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COLORADO RIVER SUB-BASIN OF WESTERN GULF DRAINAGE BASIN

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Dallas, Texas

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REPORT ON WATER POLLUTION

COLORADO RIVER SUB-BASIN

OF

WESTERN GULF DRAINAGE BASIN

JANUARY 1952

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Prepared by

FEDERAL SECURITY AGENCY
Public Health Service
Division of Water Pollution Control
Western Gulf and Colorado Drainage Basin Office

in cooperation with

New Mexico Department of Public Health
and
Texas State Department of Health

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INTRODUCTION

The subject of stream pollution has always received considerable attention in the States in which the Colorado (of Texas) River Basin is located. However, outstanding progress has been made in pollution abatement since 1946 as a result of concentrated efforts of the water pollution control agencies. This increased activity indicates the concern expressed by public officials, professional and lay groups and the general public. All of these groups recognize that pollution prevention and abatement measures must be continued and, in some areas, increased or the basin's valuable water resources will be seriously damaged and economic development, which is dependent on these water resources, greatly hampered.

The report on the Colorado River Sub-Basin has been prepared to aid in the continued development of the water pollution control program for the protection of the waters of the basin. It is a summary of the information and data available in January 1952, on the uses to which the water resources were put, the pollution reaching the watercourses and the damages resulting from that pollution, and the benefits which may result from pollution prevention measures in effect and those which were known to be required.

The data presented herein brings together information collected by federal and state agencies, municipalities and industries, and other interests concerned with the conservation and development of water resources. This report will serve to publicize the water pollution situation and direct the responsibility for needed corrective measures to municipalities and industries involved.

This report is also intended for use by the Public Health Service as part of the nation-wide pollution abatement program. Provisions of the Federal Water Pollution Control Act, Public Law 845, passed by the 80th Congress, June 1948, required the Surgeon General of the Public Health Service to cooperate with other Federal Agencies, with State and interstate water pollution control agencies, and with municipalities and industries in the preparation or adoption of comprehensive programs for eliminating or reducing the pollution of interstate water and tributaries thereof, and improving the sanitary condition of surface and underground waters.

It should be recognized that this report is based on data which were readily available, but admittedly incomplete. Some work still faces the water pollution control agencies in securing certain additional data for the water pollution control program for the Colorado River Sub-Basin.

Data and knowledge were sufficient to indicate the location and extent of the basin's remaining pollution problems. The list of pollution abatement projects which are included in Table L of this report represents known needs, on January 1952. Further studies and evaluation may result in some changes in the estimated requirements.

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Texas Railroad Commission

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Federal Power Commission

National Resources Committee

Other valuable sources of information include:

Federal Reserve Bank of Dallas, Texas

Lower Colorado River Authority

Texas Mid-Continent Oil and Gas Association

The Texas Almanac
published by the Dallas Morning News

Directory of Texas Manufacturers
published by the Bureau of Business Research
University of Texas.

SUMMARY

The Colorado (of Texas) River Sub-Basin is located almost entirely within Texas with only a relatively small portion in New Mexico. The river flows from its source in west Texas and southeastern New Mexico in a southeasterly direction across the center of Texas and discharges into the Gulf of Mexico. The basin has an area of approximately 42,500 square miles. About 12,000 square miles lie in the arid High Plains area and contribute very little to the flow of the river.

The climate of the area varies from semi-arid in the upper portion of the basin to moist sub-humid at the Gulf. The average annual rainfall varies from 17 inches in the upper basin to 42 inches near the Gulf. The river is not materially affected by rainfall variations or flash floods originating above Austin as the flow is controlled to a considerable extent by many large reservoirs, particularly those operated by the Lower Colorado River Authority. It is possible, however, for floods to originate below Austin.

About three-fifths of the basin's population is urban with the heaviest concentration in and around Austin, the capital of Texas. During the last decade most of the rural areas experienced a population decrease of about 7%, while the cities (particularly the larger ones) increased about 59%.

Agriculture is the leading industry in the basin economy with income about equally divided between livestock and crops. Cattle raising predominates in the upper area of the basin while cotton and other row crops lead in importance in the middle and lower parts of the basin. Irrigation is practiced extensively for crop production in the middle and upper basin and for rice cultivation near the Gulf.

Oil production represents the second largest source of income with the major producing fields in the area between Snyder and Odessa. Many of the older wells are now producing large amounts of salt-water wastes. Continued attention must be given to the control of this oil field waste and of refinery wastes in the basin, particularly in the "critical-water" areas of the upper basin, so that the quality of surface and ground water can be maintained at present high levels.

Most of the basin's industries are engaged in processing agricultural and petroleum products. There is no specific concentration of industry in any one area of the basin. It is believed, however, that industry will become increasingly important in the lower basin since assured water supplies and low-cost electric power are available from the Lower Colorado River Authority developments.

Silt data for the basin are incomplete. Several silt stations, formerly operated, were abandoned after the construction of the Inks and Buchanan Dams. Data collected prior to that time, although incomplete, indicate an annual river silt load of over 9 million tons at Columbus. Further soil conservation measures are needed to reduce this pollution.

The clear streams of the Hill Country (Edwards Plateau) area and the many reservoirs provide swimming, fishing, and boating and are used extensively for recreation. It is important that pollution be kept from damaging these waters.

The water pollution control activities in the Colorado (of Texas) River Basin are carried on in New Mexico by the Division of Sanitary Engineering and Sanitation of the New Mexico Department of Public Health. In Texas these activities are handled by the Division of Sanitary Engineering of the Texas State Department of Health, the Game and Fish Commission, and the Office of the Attorney General.

The results of the water pollution control programs are in evidence throughout the basin. All but two of the 57 municipalities which had sewerage systems were also served by sewage treatment plants. Twenty-one of these municipalities replaced existing plants or constructed sewers and new treatment plants since 1946. However, many of the older plants needed improved operation, replacement, additions or enlargements. It is estimated that the construction of the facilities which the State pollution control agencies considered necessary (January 1952) to correct municipal sewage pollution in the basin will cost $880,000. Pollution from domestic sewage has been controlled to the point where it is usually of only minor significance and, to date, it has caused only local nuisances.

Most of the industries in the basin are connected to city sewerage systems. Of the 40 sources where industrial wastes were known to be discharged directly to the watercourse, 30 were known to have treatment facilities, 4 had no treatment facilities, and information was not available for the other 6. Twenty-five of the known treatment facilities were salt water injection wells used to dispose of oil field salt water waste to non-potable water strata. There have been no instances reported where the disposal of industrial wastes have seriously damaged the waters of the basin.

CONCLUSIONS

1. The development of the Colorado River Basin depends, in a large measure, on maintaining water of suitable quality.

2. Irrigation is of major importance in the middle and upper parts of the basin where large volumes of surface and underground water are used for crop production. Large quantities of surface water are also used for rice irrigation in the counties near the Gulf of Mexico. There are no known instances where the discharge of sewage or industrial wastes has seriously affected this important water use.

3. There are many reservoirs, which furnish water for recreation, irrigation, domestic and municipal water supplies, and power production, and are used to regulate flood and low water flows.

4. Pollution from domestic sewage is, in general, confined to localized areas immediately below the point where the sewage plant effluent or the sewer discharges to the stream. No serious damages to the basin's waters from domestic sewage or industrial wastes have been reported.

5. The excellent results of the active water pollution control programs of the Texas and New Mexico pollution control agencies are evidenced throughout the basin. In January 1952, approximately 50 percent of the basin's population were served by sewerage systems and 99 percent of the persons served by sewerage systems were also served by sewage treatment plants (12 percent were primary and 88 percent were secondary plants). Twelve municipalities were actively engaged in preparing plans or constructing sewage treatment plants to provide a higher degree of treatment for domestic wastes.

6. The present control of brine and oil wastes from oil wells and refineries should be continued so that water uses will not be affected. An expanded utilization of salt water injection wells can be anticipated for the future.

7. Silt pollution represents the most serious problem in the basin and causes the major damages to the basin's surface waters. Soil conservation programs now operating in many parts of the basin reduce erosion with a resultant reduction of silt damages to surface waters. However, a need for additional soil conservation work is indicated by the present silt load of the rivers.

8. The many reservoirs and some of the clear streams in the Edwards Plateau (Hill Country) area are used extensively for recreation. These should continue to be maintained in an acceptable condition both from a public health and an aesthetic point of view.

9. Additional personnel and funds are required by the control agencies concerned with stream pollution prevention and abatement in the basin to intensify and continue the planning and execution of the pollution abatement program.

RECOMMENDATIONS

It is recommended that:

1. The program for water pollution control be continued and intensified.

2. All groups and individuals, having an interest in water use and pollution control, assist the official water pollution control agencies in carrying out their educational program to bring the importance of the water pollution control program before the public.

3. The State legislatures provide the State agencies, concerned with water pollution control, with sufficient funds to insure the continuance of an intensified water pollution control program.

4. The State agencies, concerned with water pollution control, continue their efforts in encouraging municipalities and industry to develop and maintain efficient waste treatment plant operation. This will insure maximum return from investments in treatment facilities.

5. In accordance with recommendations of the State pollution control agencies, as of January 1952, improved domestic sewage facilities be provided at the following locations (all in Texas):

Austin*	Fredericksburg	O'Donnell
Ballinger	Giddings*	San Angelo*
Bastrop	Junction**	Sanatorium
Big Lake*	La Grange*	San Saba*
Big Spring**	Loraine	Santa Anna
Brady	Menard	Seagraves
Cross Plains	Midland**	Smithville***
		Stanton
		Wharton

* Active Planning.
** Plant under construction.
*** Smithville actively planning to divert sewage now treated by a privately owned septic tank to municipal sewerage system which includes a secondary sewage treatment plant.

Improved operation of existing sewage treatment facilities be provided at:

Big Lake	Loraine	Sanatorium
Fayetteville	Manor School	Smithville -
Giddings -	Menard	(primary plant)
(2 plants)	Midland	Stanton
La Grange	O'Donnell	Winters

6. Needs for new industrial waste treatment plants and the status of existing treatment plants be determined where necessary to complete the water pollution control picture.

7. Legislation be considered to provide more positive control over the disposal of oil field wastes whereby the operator is charged with the responsibility of disposing of such wastes satisfactorily.

8. Soil conservation programs be expanded to keep valuable top soil on the land and silt pollution from the watercourse. Additional sediment load stations be strategically located to evaluate the present control program and indicate where additional conservation measures are needed.

HISTORICAL DEVELOPMENT

The Colorado River Valley was crossed in 1535 by the first group of Europeans to visit this area, comprising Cabeza de Vaca and his companions. They had previously been shipwrecked on the coast of Texas and were working their way to the Spanish settlements far to the west.

The name "Rio Colorado" given to it by the Spanish literally translated means "red river".

There may have been settlements on the Colorado River previous to 1683 when the San Clemente Mission was founded by the Spanish priests but reference to these has not been found in a limited research. In 1756 San Saba Mission was founded by Spanish priests in an endeavor to "civilize" the rugged Apache Indians. Although a military garrison was established the year following the founding of the mission, the Indians wiped out the mission and its priests in 1758. The military garrison was continued until 1772, to maintain Spanish sovereignty in the region.

The livestock brought in with the Spanish missions in this river basin were the ancestors of the wild herds found and developed by the first Anglo-American settlers. Cattle raising was started in the 1840's in the middle part of the basin area. It was not until the period following the Civil War that the large ranches developed.

One economic contribution made by ranchers in the Colorado River Valley was the importation, in the early 20th Century, of tick and tick fever resistant Brahma cattle from India. The ranching industry created by favorable climate, soils, and vegetation, has depended on the river for stock watering and irrigation since the earliest settlers established ranches along the river and its tributaries.

One of the first dams built on the Colorado River was a hydroelectric development to serve the city of Austin and vicinity. This was built in 1888, destroyed by flood in 1900 and rebuilt in 1912.

Oil was discovered in this river basin in Coleman County in 1902, in Matagorda County in 1904, and in Bastrop County in 1913. During the 32 years from 1917 to 1948, inclusive, oil has been found in 42 of the basin's counties.

PHYSICAL DESCRIPTION

The Colorado (of Texas) River Basin is located mostly in Texas (approximately 96%) with a relatively small area in New Mexico (approximately 4%) and is a part of the Western Gulf Drainage Basin. It is bounded on the north and east by the watershed of the Brazos River and on the south and west by the watersheds of the Guadalupe, Nueces, Devils, and Pecos Rivers. The basin is about 580 miles long, and about 100 to 150 miles wide in the upper and central portions and narrows to a cofridor 10 to 15 miles wide in the lower 100 mile reach of the river. The basin has an area of about 42,500 square miles.

The river flows from its source in western Texas and southeastern New Mexico in a general southeasterly direction across the State of Texas, passing through the geographical center of the state, and discharges into the Gulf of Mexico through Matagorda Bay.

In its course through Texas, the Colorado River crosses three major physiographic divisions, namely, the High Plains, the North Central Plains, and the Coastal Plains. About one-fourth of the basin, the upper 12,000 square miles, lies in the High Plains Area, a high (3,500 feet average elevation), flat, arid region which contributes little to the flow of the river. From the High Plains Area the river flows in a southeasterly direction across the North Central Plains until it reaches the Balcones Escarpment just north of the city of Austin (550 feet approximate elevation). From Austin to the Gulf, a distance of about 290 river miles, the Colorado is a turbid meandering river of gentle gradient.

There are five major tributaries of the Colorado River. They are, with their approximate drainage areas, as follows: Concho River (5,900 sq. mi.); Pecan Bayou (2,900 sq. mi.); San Saba River (3,200 sq. mi.); Llano River (4,500 sq. mi.); and Pedernales River (1,300 sq. mi.).

There are many reservoirs in the basin which furnish water for irrigation, municipal water supplies, power production and recreation. In addition, they help regulate flood and low water flows. The major reservoirs in this basin include:

Name	Stream	Storage Acre-feet
Existing Reservoirs		
Lake Buchanan	Colorado River	992,000
Lake Travis	" "	1,950,000
Lake Inks	" "	12,200
Lake Austin	" "	21,500
Lake Nasworthy	Concho River	10,500

Lake Brownwood	Pecan Bayou	137,300
Coleman Lake	Hords Creek	24,000
San Angelo	Concho River	391,500
Hords Creek	Hords Creek	25,300
Morgan Creek	Morgan Creek	30,200
Oak Creek	Oak Creek	41,000

Reservoirs under Construction or in Planning Stage

Enlargement of Lake Brownwood	Pecan Bayou	575,600
Colorado City	Colorado River	111,000
Granite Shoals	" "	177,000
Marble Falls	" "	28,000
Colorado River Municipal Water District	" "	204,000

The climate of the area varies from semi-arid in the upper portion of the basin to moist sub-humid in the lower gulf area. It is characterized by its diversity and sudden changes. The entire basin is subject to heavy rainstorms and the gulf area to occasional hurricanes.

The realative humidity varies considerably throughout the basin as does temperature, frost dates and precipitation. Approximate climatic data are given below:

	Upper Basin	Central Basin	Lower Basin
Temperature			
Normal January	42	48	55
Normal July	80	85	83
Extreme Maximum	112	115	106
Extreme Minimum	-23	- 5	3
Killing Frost			
Last in Spring	Mar. 5	Mar. 20	Feb. 26
First in Fall	Nov. 5	Nov. 15	Nov. 30
Growing Season(days)	215	235	277
Average Normal Rainfall (in. per yr.)	17	27	42
Average Relative Humidity			
Jan. 8:00 AM	Under60	75	85
Jan. Noon	Under50	55	75
July 8:00 AM	75	75	85
July Noon	Under40	45	65

Evaporation at Austin, Texas, varies from 2 to 3 inches per month during the winter to 10 or more inches per month in August. Yearly evaporation amounts to 60 - 70 inches, an important factor in the design of reservoirs and irrigation works.

The flow of the Colorado River in the upper and middle portion

of the basin not only varies from year to year, but also from season to season. Since 1938, the river, below Austin, has been regulated by the reservoirs operated by the Lower Colorado River Authority. Floods originating above Austin have been kept to a minimum in the lower basin. Some additional flood control measures are needed to control floods originating below Austin.

The following table indicates some of the flow conditions experienced at various stations on the river.

Station	Years of Record	Discharge in Second-feet Maximum	Minimum	Average
Ballinger	42	75,400	0	402
Winchell	20	76,100	0	751
Austin	51	481,000	13	2,637
*Columbus	31	152,000	80	3,225

* A considerable amount of water is pumped from the river below this station and used for irrigation (mostly rice).

Although in some states the knowledge of stream flows is of value in determining pollution abatement measures necessary to economically protect legitimate water uses, interpretation of the State's anti-pollution statutes by the Texas courts have been such as to establish a policy requiring complete treatment of wastes regardless of the volume of receiving waters. Present stream gaging coverage is considered sufficient to establish general basin hydrology. As flow data are not used for pollution control purposes the cost of installing additional gaging stations cannot be justified solely on this basis.

Appendix IV contains an index of records for the Colorado Basin collected by the U. S. Geological Survey and other agencies, indicating discharge, sediment, chemical quality and temperatures.

Runoff has been increased by over-grazing, and by inadequate soil conservation measures in the middle and upper portions of the basin. This has contributed to flash floods with resultant heavy silt concentration and thereby added to the pollution load of the river.

The Colorado Basin extends entirely across Texas in a southeasterly direction and crosses the High Plains, North Central Plains and the Coastal Plains. This basin crosses the geological formations of the area at approximately right angles which accounts for a great variation in soil types. The rocks that cover it are composed chiefly of alternating layers of sand, gravel, sandstone, limestone, clay and shale.

The principal soil and land use areas occur from the headwaters to the mouth as follows:

1. High plains - dry level plains; sandy soils; some dune sands; little farming; large ranches; beef represents principal

production.

2. High plains cotton area - smooth level plains; light sandy soils; Amarillo sandy loams; cotton and grain sorghums; cattle grazing in the less developed parts of the area; large scale methods; cotton, grain, and beef represents principal production.

3. Low rolling plains - rolling topography; wide variations in soil types; reddish brown and dark soils with some sandy areas; cotton and grain sorghums; cattle raising areas alternating; farming predominates.

4. Edwards Plateau area - much rough land; shallow stony soils of limestone origin; live oak, cedar, and shin oak brush; land used for grazing; cattle, sheep and goats represent principal production.

5. Black Prairie area - level to rolling topography; black fertile soils of varying depths; land used mostly for farming; cotton and corn represent principal production.

6. Post Oak area - mostly level topography; sandy and sandy loam soils; farming mostly on interior prairies and bottom lands; cotton, corn, truck crops and beef represent principal production.

7. Coast Prairie area - level topography with poor drainage; varying soils; black and gray clays, some sandy types; cotton, corn, rice, and beef represent principal production.

There are several water-bearing formations under the basin. These are in ascending order: the Ogallala, Edwards Limestone, Wilcox Group, Carrizo Sand, Catahoula Tuff and Sand, Oakville Sandstone, Lagarto Clay, Goliad-Willis-Lissie Group, Beaumont Clay, and recent alluvium deposits. These formations, except the Ogallala formation, have an increasing depth as they approach the Gulf and each has an outcrop from which it dips beneath other formations. Because of these outcrops it may be possible for surface pollution to enter the underground water formations and proper disposal of sewage and industrial waste must be practiced to prevent contamination of these underground waters.

The U. S. Geological Survey Water Supply Paper 913 points out the presence of several "sinks" in the Edwards Limestone in the Big Spring oil producing area. The paper further states that, "The ground water may eventually become contaminated by salt water from the oil wells, if it is not already contaminated."

ECONOMIC DEVELOPMENT

General

The economic development of the Colorado (of Texas) River Basin is, to a large extent, controlled by its water, soils, and geological formations and has been largely limited to farming, grazing, and oil production. There are no highly developed industrial areas in the basin. The few industries of the basin are widely dispersed and are limited to the processing of agricultural and petroleum products.

Population

The number of persons living in the Colorado River Basin in 1950 was about 657,000, of which approximately 23,000 (3.5%) resided in New Mexico and 634,000 (96.5%) resided in Texas. The urban-rural population distribution of the basin included approximately 391,000 (59.5%) persons living in communities of 2,500 or larger and 266,000 (40.5%) in rural areas.

In the 1930-1940 decade the basin population increased 12 percent while that of the nation as a whole increased only 7 percent. During the 1940-1950 decade the basin population increased 23 percent as compared with the nation's growth of about 14 percent.

The ten year growth of the 30 communities in the basin with populations of 2,500 or more (1950 census) was from about 246,000 to about 391,000--a gain of about 145,000 or 59 percent. The rural population, on the other hand, dropped from about 287,000 to about 266,000 representing a loss of about 21,000 persons or 7 percent.

During this 10 year interval the greatest numerical urban population gains occurred in the cities of Austin and San Angelo. These two cities had a combined increase of approximately 70,000 persons (62%). Five communities have experienced increases of 50 to 216 percent, and all others, a lesser increase.

Communities which heretofore had no sewers grew to the point where such facilities were desirable, while many of the already sewered communities grew until their systems and treatment plants no longer had sufficient capacity. This growth, together with the educational and promotional activities of the pollution control agencies for better sanitary facilities, resulted in the construction of numerous new sewer systems and treatment plants and the replacement or enlargement of many existing systems and plants.

See Appendix III for the census figures of communities in the basin with 2,500 or more persons and other population data.

Lower Colorado River Authority

The Lower Colorado River Authority was created by the Texas State Legislature in 1934 to (1) control devastating floods, (2) conserve, store and distribute water for irrigation, power and other purposes, (3) develop, generate, distribute and sell power, and (4) protect the watershed land resources from soil erosion and to develop forests. As a political sub-division of the State of Texas, the Lower Colorado River Authority is a reclamation and conservation district composed of ten counties located along the lower river.

The rights of the Authority to impound, use, and sell water for hydroelectric power is subordinate and inferior to (1) the rights of cities and towns within the watershed to build dams and impound flood waters for municipal purposes, and (2) the rights of any citizen of Texas or political body thereof to build dams and impound floodwaters of the watershed for domestic use and irrigation.

The Authority is a multipurpose organization with interests and activities, listed in the order of importance as follows:

(1) Flood Control - Floods on the Colorado River have caused many millions of dollars worth of damage in the past. The completion of the dams above Austin since 1938 has considerably relieved flood conditions in the Lower Valley from floods originating above Austin.

(2) Water Supply for Austin - The storage capacity of the Authority's reservoirs furnishes a dependable supply of water for municipal use at Austin and provides a potential industrial supply.

(3) Irrigation - Prior to the completion of the Authority's reservoirs, large losses were sustained by the rice growers during drought periods when river flows were insufficient to supply needed water. Dependable river flows are now maintained and rice acreage has almost doubled since 1938.

(4) Hydroelectric Power - At present the Authority serves low cost power to approximately 72,000 individual farm, ranch, and urban customers living in 41 Central Texas counties and 250 municipalities and small communities. Power sales constitute about 95 percent of the income of the Authority and have financed the expension, construction, maintenance and operation of its many projects.

(5) Employment - The Authority's construction projects furnish work and income for the watershed residents. This employment was of considerable importance during the Thirties. At present the Authority furnishes employment to a great number of people through its operational activities both directly and indirectly.

(6) River Canalization - The control of the low-water and flood flows has made canalization of the river to Austin a possibility. A canal from the Gulf to Bay City has been authorized by Congress but no funds have, as yet, been appropriated.

(7) Soil Conservation - Flood control by retardation of run-off through soil conservation and reforestation is practiced. Within the last few years the Authority has made funds available for improvement of farm and grazing lands in the watershed.

(8) Recreation - The recreational facilities of the area under Authority control have been greatly improved by the large reservoirs and dependable river flows. The reservoirs offer facilities for swimming, picnicking, camping, and fishing.

Agriculture

Crop and livestock production is the basic industry in the basin. Livestock raising, principally cattle, sheep, goats, and horses, was the first activity in which early settlers engaged. Livestock also constituted the main assets of the Spanish missions in the Eighteenth Century. The Spanish cow was the pioneer of beef development and today's Rambouillet sheep and Angora goats are descendents of animals brought to the Southwest by Spaniards and Mexicans. Livestock raising was the principal agricultural activity until shortly before the Civil War, when grain and row crops were introduced by immigrants from the Southern States.

The colorful cattle drives, developed to reach good markets, constituted the only means of transporting the cattle until the 1870's when railroads entered the basin. Factors which aided ranch development during the last of the 19th Century were the introduction of barbed wire and the improvement of the windmill.

During the middle of the 19th Century, farmers began to enter the basin and there were many attempts on the part of the cattlemen to keep them from fencing in what had been previously open range land. Farmers, however, gradually took over the broad expanse of fertile land that would readily grow cotton, grains, and row crops. Crops are now a major source of the basin's income.

Cotton represents the largest source of farm crop income in this basin. The future role of cotton cannot be predicted; however, the tendency seems to be toward diversified rather than specialized single crop farming. In 1942 the cotton crop in the Colorado River Basin was about 444,000 bales or 15 percent of the total Texas cotton production. In 1950, a preliminary count of bales ginned in the basin totalled 416,000 or 16 percent of the Texas crops

Mineral Resources

Oil production represents the second largest source of income in the basin, agriculture being the largest. The first oil field of leading importance was the Big Lake oil field in Reagan County, Texas, discovered in 1923. Major fields have been discovered in Upton, Winkler, Howard, Glasscock, Andrews, Ector, Cochran, Hockley, Yoakum, Wharton, Gaines, Scurry, Matagorda Counties in Texas and Lea County, New Mexico. Most of these fields are located in the upper portion of the basin. There have been many smaller discoveries in other parts of the basin.

The most recent discovery (1948) is the Scurry Reef, centered in Scurry County. The economic impact of this field is illustrated by the growth of the city of Snyder, which increased from about 3,800 to 12,000, or about 216% from 1940 to 1950, and at times during the decade reached almost 20,000. Many of the basin's other cities have experienced similar growth fluctuations. We may expect a continued increase in population, employment, petroleum production, retail sales, and personal incomes in the oil producing areas. The oil production in the Texas portion of the basin during 1949 was about 100 million barrels. Old oil fields usually produce large amounts of salt water wastes which aggrevate the problem of proper waste disposal. Only minor damages to water uses from these wastes have been reported to occur in the basin.

There are many deposits of other minerals in the basin. These include granite, limestone, aggragates, glass sand, brick and tile clay, talc, gypsum, graphite, celestite, strontium, lead, and copper. At present there is no large scale production of any of these minerals.

The lumbering industry is of little importance in the basin, being limited to the production of cedar and oak posts.

Manufacturing

Practically all manufacturing in the basin is limited to the processing of agricultural products and the refining of petroleum products. An expansion of petroleum refineries may be expected in the upper basin. The production and distribution of low cost electric power by the Lower Colorado River Authority may bring some industries to the middle and lower basin. Industrial development depends, in large measure, on the continued availability of satisfactory water. Pollution prevention and abatement is particularly important in the upper part of the basin where oil production is extensive and water supplies are critical.

Power

As of January 1952, there were 36 power plant installations in the basin with a total generating capacity of about 415,000 kilowatts. Eight of these plants, all operated by the Lower Colorado River Authority, were hydroelectric plants with a combined capacity of 203,270 kilowatts. Six were steam plants with a capacity of 176,850 kilowatts and the other 22 were internal combustion engine plants with a combined capacity of 35,188 kilowatts. One steam and eight internal combustion engine plants with a total capacity of about 7,500 kilowatts were owned and operated by industry for private use. All industrial power plants, except one small one, were owned and operated by petroleum industries. The Fort Worth Regional Office of the Federal Power Commission, which furnished this information, reported no known instance where pollution had affected the operation of these power plants in this basin nor had the presence of pollution been a factor in the selection of power plant sites.

Transportation

There are adequate transportation facilities throughout the basin for present needs. The area is covered with a network of first and second class highways. There are, in addition, many railroads, airlines, bus companies, trucking companies, and oil and gas pipelines which serve the basin.

Recreation

Existing reservoirs include Austin, Inks, Travis, and Buchanan (the "Highland Lakes" of the LCRA chain) in the lower part of the basin and Lake Nasworthy, Hords Creek, Lake Brownwood and San Angelo Reservoir in the middle part of the basin. The Granite Shoals and Marble Falls Reservoirs are in the final stages of construction. These reservoirs, numerous smaller reservoirs, and some of the clear streams in the "Hill Country" provide excellent boating, fishing, and swimming facilities and attract many vacationers and tourists each year.

Fishing is reported to be good in many reservoirs and fair in some of the streams. Black and white bass, catfish, drum, sunfishes, and numerous other varieties of fish are sought by fishermen.

Game and fur-bearing animals found in the basin include white-tail deer, squirrel, racoon, muskrat, rabbit, opossum, skunk, and weasel. Game birds include quail, dove, turkey, and migratory water fowl. The Edwards Plateau region is particularly noted for its abundant game and each year attracts many hunters to the area.

The recreational facilities of the Texas State Park Board are extensively used. They include the Bastrop-Buecher State Parks near Bastrop, the Big Spring State Park near Big Spring, the Inks Lake State Park near Burnet, the Longhorn State Park near Marble Falls, and the 36th Division State Park near Brownwood.

USES OF WATER RESOURCES

General

The waters of the Colorado (of Texas) River Basin are used extensively for municipal supplies, domestic supplies, power development, irrigation, and recreation. The pollution prevention program must be continued to prevent impeding present and future development of the basin's water uses.

Present data do not permit determination of the total amount of surface water actually consumed and the amount returned to the watercourse after use. The existing primary water uses are indicated on Map No. 1.

The annual discharge at Columbus (about 135 river miles above the mouth of the river) averages about 2,200,000 acre-feet after most of the upstream water demands have been met. (About 300,000 acre-feet annually is used for irrigation below Columbus). This indicates a substantial amount of water which is unused at present.

The water appropriation records of the Texas Board of Water Engineers indicate a total of almost 9,000,000 acre-feet of water appropriated for various uses. Permits have been issued for over 8,000,000 acre-feet of impoundments, including hydroelectric development. The total amount of water appropriated for hydroelectric power is nearly 7,500,000 acre-feet, which represents the largest single type of appropriation. The total annual use of surface waters provided by these appropriations approximates 3,000,000 acre-feet (over 2,500,000 acre-feet for power production). Appendix II contains a tabulation of water appropriations, uses, and supplies.

It is believed that present and future reservoirs will have a marked influence on the development of the basin by providing a sustained source of hydroelectric power; by regulation of the river flow making flood flows available for economic use; by silt retention and improvement of water quality; and by the development of extensive recreational facilities.

Municipal Use

Municipal water supplies constitute one of the most important uses of water resources. Most of the larger municipalities in the middle and lower part of the basin obtain their water supplies from surface sources. Ground water is used by most municipalities in the upper part of the basin.

Eleven municipalities serve about 280,000 persons with almost 28 million gallons per day (30,000 acre-feet yearly) from surface supplies. The water supplies of 47 municipalities (2 in New Mexico) with a total population of about 190,000 utilize more than 20 MGD ground water. There are 2 municipalities in the basin with a total

population served of almost 17,000 which use over 2 MGD of combined ground and surface water.

The water bearing strata so far employed in the upper basin cannot supply sufficient water to satisfy the large demand of the rapidly growing population and most of the larger municipalities may soon be forced to use surface water. At the present time the larger cities in the upper basin are experiencing considerable difficulty in obtaining adequate supplies. The Colorado River Municipal Water District has been formed recently to build a reservoir and develop a dependable surface water supply for this area. This reservoir will replace the present inadequate ground water supplies of Odessa, Big Spring and Snyder, Texas.

Many of the municipalities (a total of 19 in January 1952), particularly in the upper basin, utilize their sewage plant effluent for land irrigation. Each community using broad irrigation must be classed as a total consumer of its water supply as no water is returned to the streams for re-use by others.

Power Production

Since the development of the Lower Colorado River Authority in the late 30's the use of water for the production of hydro-electric power has increased in importance until more than 2,500,000 acre-feet per year are used. An ultimate 7,500,000 acre-feet are allocated for this purpose under present appropriation grants.

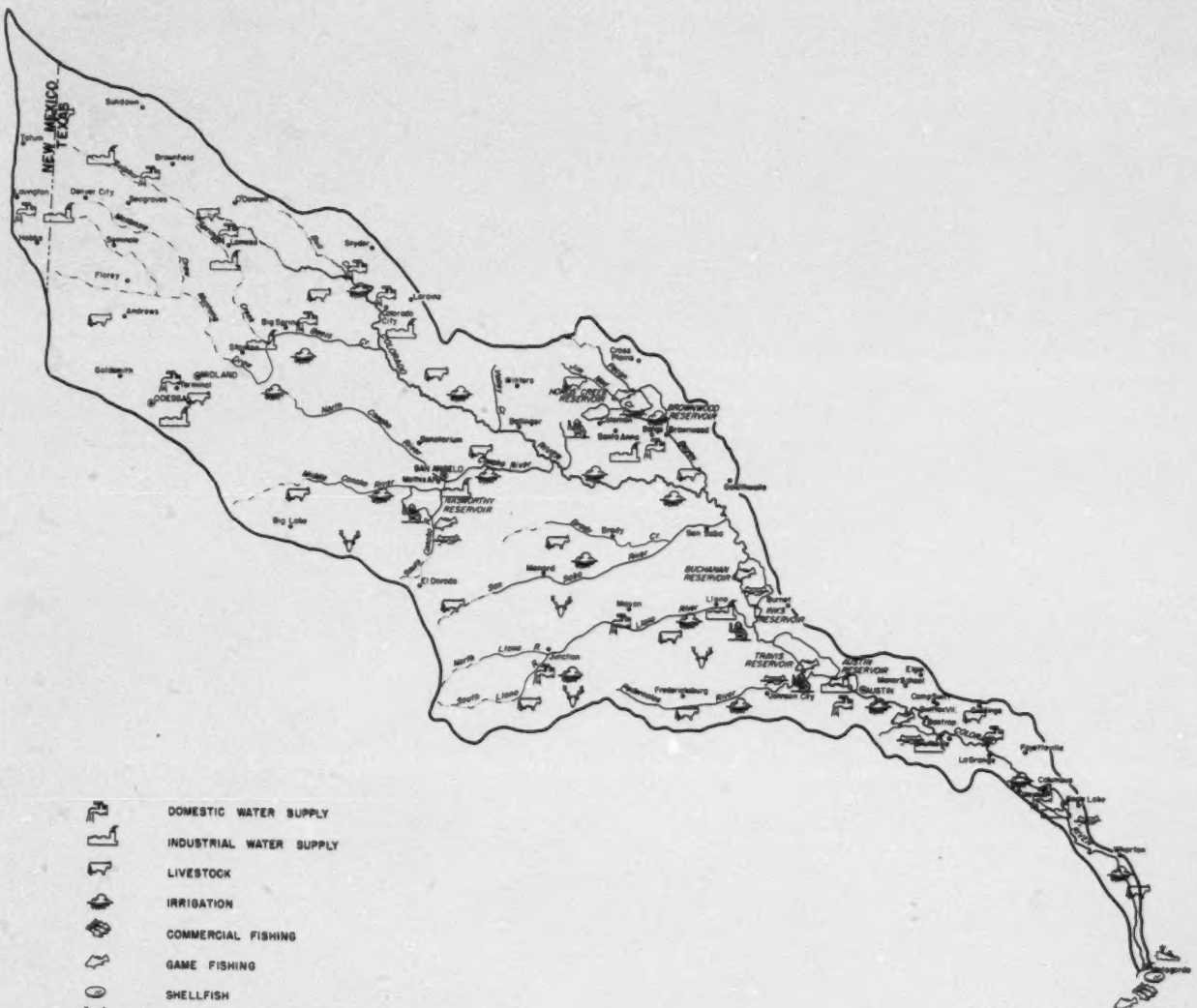
The consumptive use represented by evaporation from the power reservoirs was not secured. However, assuming a net evaporation loss of 36 inches, the loss from the 4 main impoundments of the Lower Colorado River Authority is estimated to be about 200,000 acre-feet annually.

Agricultural Use

Irrigation constitutes the largest consumptive use of the water resources. Over 280,000 acre-feet of surface water are appropriated for the irrigation of more than 160,000 acres. A large portion of this acreage (100,000 in 1947) is located in the lower part of the basin and is used for rice cultivation. Most of the remainder is used for crops in the middle part of the basin. Irrigation water for approximately 500,000 acres in the upper part of the basin is obtained from ground water sources.

Industrial Use

Water use by industry is of no great significance in the basin at present. There is a limited amount of water used in the Austin area, in most cases, by small industries. The Cosden Refinery in Big Spring, Texas buys the sewage plant effluent from the City and uses it for processing (mostly cooling) water. As the basin contains many desirable plant sites, additional water quality stations are deemed advisable in some areas to secure water quality data for use by industry when locating future developments.


NEW MEXICO
TEXAS
Sundown
Brownfield
Seminole
Denver City
Plains
Levelland
Morton
Lamesa
Hobbs
Tatum
Andrews
Big Spring
Colorado City
Loraine
Goldsmith
ODESSA
MIDLAND
Stanton
Garden City
Sterling
Coahoma
Big Lake
El Dorado
Menard
Mason
Llano
Junction
Fredericksburg
Kerrville
Boerne
San Marcos
Seguin
Gonzales
Cuero
Yoakum
Victoria
Edna
Ganado
Port Lavaca
Rockport
Aransas Pass
Corpus Christi
Alice
Kingsville
Falfurrias
Harlingen
Brownsville
Raymondville
Mercedes
Weslaco
Pharr
McALLEN
Edinburg
Mission
Hidalgo
Rio Grande City
Laredo
Eagle Pass
Del Rio
Sonora
Ozona
Rocksprings
Uvalde
Hondo
Pecos
Crane
Iraan
Fort Stockton
Sheffield
Ozona
Sonora
Junction

Recreational Use

Recreational use of the waters of the basin is limited largely to the reservoirs and some of the clear tributaries. The many large reservoirs offer excellent boating, fishing, and swimming opportunities. In addition, a large recreational use is made of the clear, fast flowing tributaries, the Perdenales, Llano, San Saba, and Concho Rivers in the "Hill Country" area. Waters are used extensively in several of the recreational units provided and maintained by the Texas State Park Board.

Other Uses

The surface waters of the basin must generally be utilized for the final disposal of municipal and industrial wastes. In thirty-seven instances, however, the sewage plant effluent does not reach flowing streams. Due to the high degree of treatment prevalent in the basin the receiving waters are in excellent condition.

In common with most of the Gulf area the waters of the basin near and on the Gulf are used for sport and commercial fishing.

The Intracoastal Waterway traverses the lower portion of the basin. This is an important shipping route and makes transportation an important water use.

POLLUTION CONTRIBUTED TO WATER RESOURCES

Municipal

All but two of the fifty-seven 1/sewered municipalities in the Colorado River Basin, or 96 percent, had sewage treatment plants and were providing some degree of sewage treatment in January 1952. The fifty-seven sewered municipalities had an approximate 1950 population of more than 420,000 persons. The sewerage systems of these communities served more than 330,000 persons. Table 1 of Appendix I contains basic data on sources of municipal pollution.

Six municipalities 2/were served by 7 primary treatment plants, 50 municipalities were served by 50 secondary treatment plants. Of these 57 plants, 14 were known to need improved operation and 20 had unsatisfactory facilities and needed replacement, additions, or enlargements.

Bastrop and Wharton with a combined sewered population of 4,000 were the only two municipalities in the basin which were discharging sewage directly to the watercourse without treatment.

Table A shows that 56 municipalities, as of January 1952, served a population of about 332,000 persons and treated their wastes to the extent that the total population equivalent discharged to the watercourse was approximately 55,000 persons. These population equivalents were calculated from analytical data or estimated plant efficiencies. The population equivalent for one municipality serving an unknown number of persons was undetermined.

The treated effluents from 37 of the sewage treatment plants, largely in the upper part of the basin, were discharged to land irrigation, lagoons, or dry lakes and did not reach flowing streams. In all of these cases the population equivalent to the watercourse was zero.

The sources of municipal pollution are shown on Map No. 2.

1/ The City of Giddings had two primary sewage treatment plants, one discharging to the Colorado River Basin and the other to the Brazos River Basin, but both plants are included in this report.

2/ Includes one municipality served with both a primary and a secondary treatment plant and one municipality served by two primary treatment plants.

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TABLE A

SOURCES OF POLLUTION

MUNICIPAL

January 1952

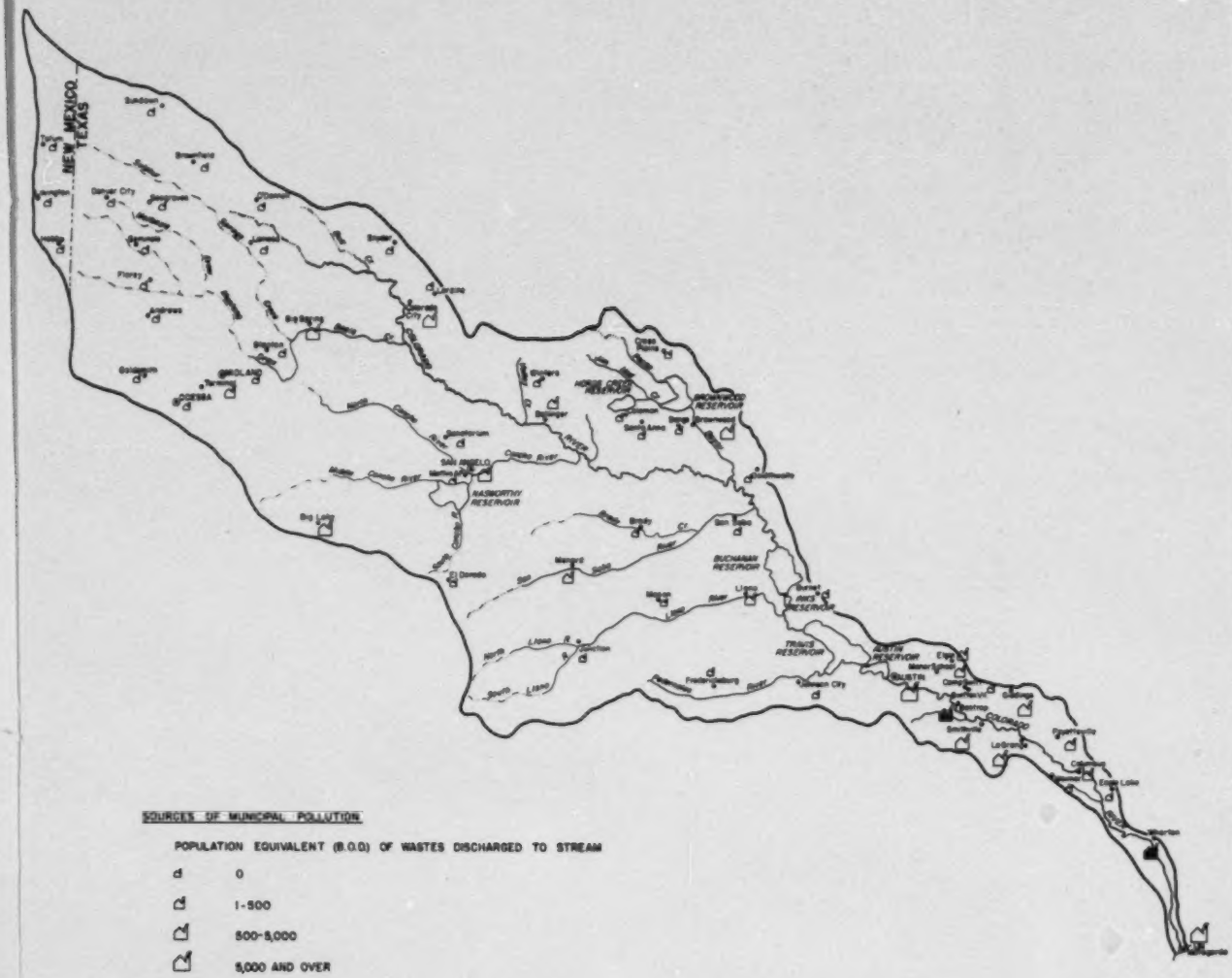
Municipalities*	Sources of Pollution (In Number of Municipalities*)	Population Served by Sewerage System	Amount of Pollution Discharged to Watercourse (In Terms of Equivalent Number of People**)
Having data on pollution load discharged to watercourse	56 (1)	332,236	54,581
Having population data available (Data on pollution load to watercourse incomplete or not available)	1 (2)	Unknown	Undetermined
TOTAL	57	332,236	XXXXXXX

* Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, town significant institutions, resorts, recreational centers, or other popula n centers.

** Includes industrial wastes discharged into municipal sewerage systems.

(1) Includes 37 municipalities which discharged to irrigation, lagoons, or dry lakes and therefore had no PE to the watercourse.

(2) Municipality which recently completed a new sewerage system and plant with the population served unknown.



SOURCES OF MUNICIPAL POLLUTION

POPULATION EQUIVALENT (B.O.D.) OF WASTES DISCHARGED TO STREAM

- 0
- 1-500
- 500-5,000
- 5,000 AND OVER
- UNDETERMINED

EXISTING TREATMENT FACILITIES

- MUNICIPALITIES WITH TREATMENT FACILITIES
- MUNICIPALITIES WITH TREATMENT FACILITIES UNDETERMINED
- MUNICIPALITIES WITH NO TREATMENT FACILITIES

COLORADO RIVER BASIN
LOCATION MAP

23-A

SCALE OF MILES
0 5 0 10 20 30 40 50

COLORADO RIVER BASIN
SOURCES OF MUNICIPAL POLLUTION
AND
EXISTING TREATMENT FACILITIES
FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP NO. 2

Industrial

Most of the basin's industries are connected to city sewerage systems and are thereby eliminated as separate sources of pollution. As indicated in Table B, there were 40 known sources of industrial pollution in the basin in January 1952 which had separate outlets and did not discharge to municipal sewerage systems. Twenty-five of these were salt water injection wells in the Texas portion of the basin, which were used to dispose of oil field waste into sub-surface strata. A small amount of salt water is produced in New Mexico but, to date, has created no problem. The total number of oil wells in the basin producing wastes of a pollutional nature or the amount of waste produced were unknown. It is estimated, however, that the 25 injection wells discharged more than 792,000 gallons daily to underground strata (containing non-potable water). The quantity or quality of the other 15 sources of industrial pollution were unknown except in the case of three industries which discharged to land irrigation and their wastes rarely reached surface waters.

Due to the limited field personnel of the Texas water pollution enforcement agencies it has been necessary to follow a policy of investigating only those pollution conditions which are reported to the agencies in the form of complaints or which are suspected of causing trouble. Consequantly, it is entirely possible that minor pollution situations exist and have not been investigated.

There are thousands of producing oil wells in the basin with a large concentration in the upper part. Much of the salt water produced in this upper basin is disposed of in holding pits, evaporation ponds and wet-weather lakes (dry lakes with no outlet). However, the Texas water pollution control agencies do not recognize this procedure as a satisfactory method of disposing of salt water. Past experiences indicate these methods to be a threat to both surface and underground water supplies while in operation and for several years after they are abandoned.

All complaints of oil field pollution reported to water pollution control agencies have been investigated and corrective action initiated in each instance. Since 1947 there have been about 25 salt water injection wells placed in operation in the basin.

TABLE B

SOURCES OF POLLUTION

INDUSTRIAL*

January 1952

Industries*	Sources of Pollution (In number of Plants)	Amount of Pollution Discharged to Watercourse (In terms of PE)
Producing Organic Wastes	3	0 ***
Producing Organic Wastes	5 **	Undetermined
Producing Inorganic Wastes	31 ****	Not applicable
Producing Wastes of Undet'd Type	5	Undetermined
Total	40 /	XXXXXXXXXXXX

* Industries having separate outlets discharging wastes directly to watercourse.

** Includes 4 industries which produce both organic and inorganic wastes.

*** Waste disposed of on land.

**** Includes 25 salt water injection wells used to dispose of wastes into sub-surface strata from an unknown number of producing oil wells.

/ Total adjusted to correct for duplication noted in footnote marked thus**.

Table 2 of Appendix I contains available basic data, as of January 1952, on sources of industrial pollution while Map No. 3 indicates the location of these sources.

The Col-Tex Refining Co. at Colorado City, discharges wastes directly to the Colorado River. At times this discharge exceeds the flow of the Colorado River.

The Cosden Petroleum Corporation buys the sewage plant effluent from the city of Big Spring and uses it as cooling water. Some refinery wastes are added to this effluent before it is discharged to Beal's Creek.

It has been reported that the Air Force installation at Goodfellow Air Field near San Angelo discharges oil and other wastes from their engine repair and maintenance shops to the watercourse.

The Cactus Sand and Gravel Company on State Highway 350 between Snyder and Big Spring discharges sand and gravel washings directly to the Colorado River. Other sand and gravel plants are also located along the river.

There have been no reports of serious damage to the basin waters by these sources of industrial wastes.

Silt

Silt contributes a large pollution load to the Colorado River waters each year. Silt determinations are being made at the present time in the middle part of the basin only (the Highland Lake Region), and data are not complete enough to permit a full evaluation of the problem.

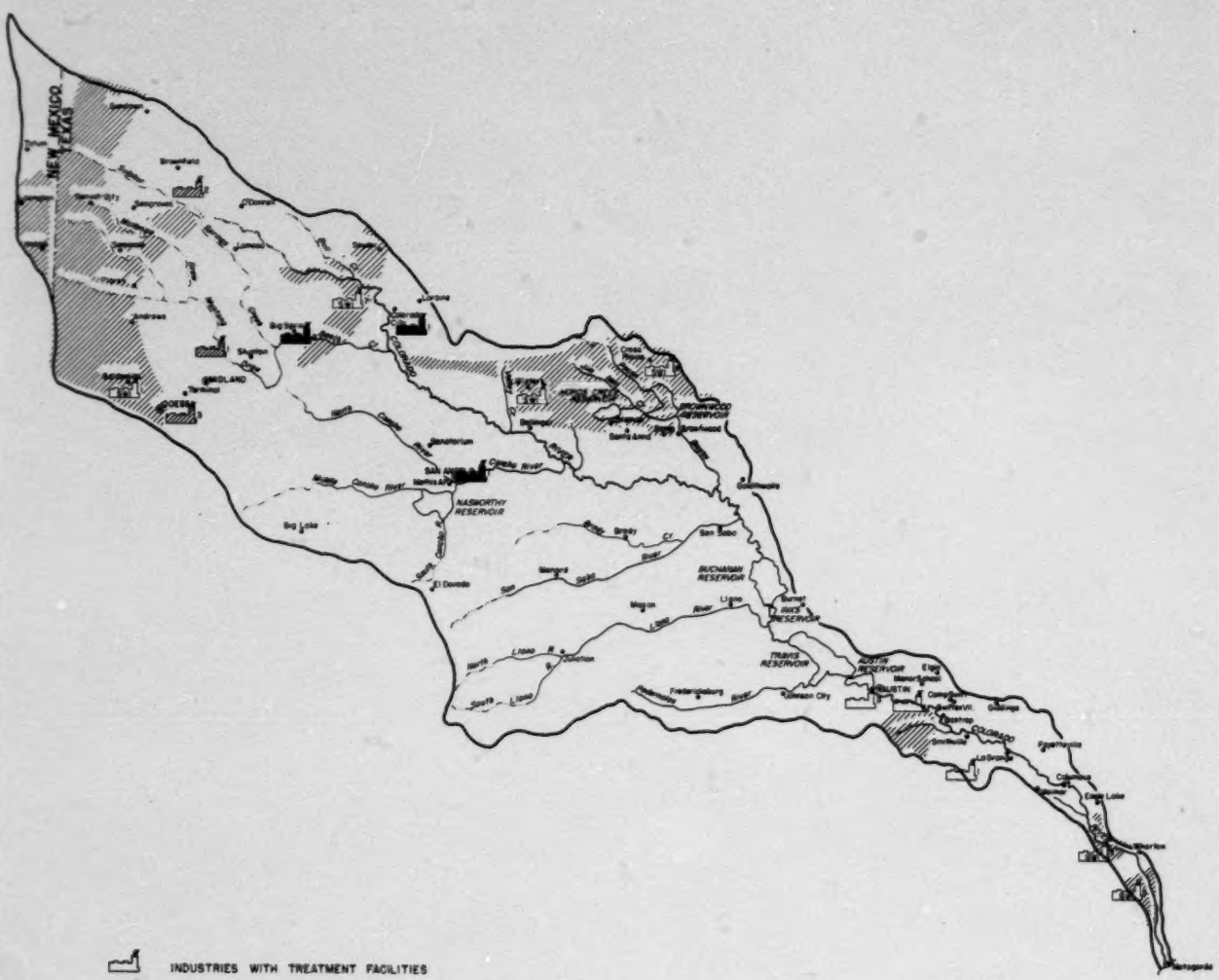
Prior to the construction of Buchanan and Inks Dams, the Texas Board of Water Engineers reported an average annual silt load on the Colorado River of almost 9,000,000 tons at Columbus, Texas. Since the construction of these dams, the station for observation of silt loading at Columbus (near the mouth of the river) has been abandoned. This prevents an evaluation of the effect of the dams in retaining silt. The river carries an annual silt load of more than 5,000,000 tons at Tow, a station above Buchanan and Inks Dams, while only 100,000 tons are reported immediately below Inks Dam, the lower of the two. This indicates a deposition of some 4,900,000 tons per annum in the two reservoirs.

Observations on the silt content of rivers are generally maintained in conjunction with anticipated reservoir construction. As soon as such construction has been completed silt readings are often discontinued. This practice prevents an accurate assessment of the pollutional effects of silt on rivers such as the Colorado and its tributaries. The maintenance of accurate observation stations on the Colorado River to determine the amount of soil pollution is one of the great needs for evaluating this source of pollution.

Other

The use of organic insecticides for the control of the boll weevil in cotton producing areas presents a potential pollution problem although there are no known instances where this pollution has affected the waters of the Colorado Basin. It might be pointed out that extensive fish mortalities, which were associated with cotton dusting operations, were noted in northern Alabama streams during the summer of 1950.

In some sections of the basin highly mineralized water resulting from natural causes is discharged to the streams, but have not seriously damaged water users.



INDUSTRIES WITH TREATMENT FACILITIES

INDUSTRIES WITH TREATMENT FACILITIES UNDETERMINED

INDUSTRIES WITH NO TREATMENT FACILITIES

NOTE-

Numbers appearing by symbols indicate total number of industrial sources of pollution in the area in the category designated.

Slot inside symbols designates salt water injection wells.

Cross hatching indicates areas of possible pollution from oil wells.

COLORADO RIVER BASIN
LOCATION MAP

27-A

SCALE OF MILES
0 5 0 10 20 30 40 50

COLORADO RIVER BASIN

SOURCES OF INDUSTRIAL POLLUTION AND EXISTING TREATMENT FACILITIES

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP NO. 3

DAMAGES TO WATER RESOURCES FROM POLLUTION

There are no flowing streams in the New Mexico portion of the basin and there have been no reported damages to ground water in that part of the basin. The Texas State Department of Health reported, as of January 1952, a downstream watercourse status of "unsatisfactory" in the case of municipal treatment plants at Austin, Giddings, and La Grange. A"nuisance" condition was reported to exist for short distances below treatment plants at Bastrop, Menard, Smithville (privately owned septic tank), and Wharton.

The U. S. Fish and Wildlife Service reported fishing damaged and requiring restoration in the Colorado River below Austin, Bastrop, and Columbus, Texas. This condition was attributed to industrial wastes from Austin and municipal sewage from Bastrop and Columbus. The city of Columbus has since completed and put into operation a secondary sewage treatment plant and the cities of Austin and Bastrop are actively planning improvements which are expected to alleviate this reported damage.

At present there have been no reports of extensive damages to water use by brine-oil wastes from the many oil wells and refineries located throughout the basin. However, New Mexico is becoming concerned over possible ground water contamination from oil field exploration "shot holes", that may reach 500 feet in depth. Although brines are not a problem at present, old fields may cause problems in the future. In view of the fact that many of the larger municipalities, particularly in the oil producing areas in the upper basin, are turning from inadequate ground sources to surface water supplies, particular care should be taken to see that present and future surface water supplies are not affected by oil field wastes.

During recent years there have been complaints that brine from oil wells is raising the chloride content of Lake Brownwood, which furnishes water to the city of Brownwood and several smaller communities. Studies made by State water pollution control agencies indicated no increase in the chloride content of the lake during 1951.

Oil-brine wastes have at times affected rice irrigation in Matagorda County during low flow-maximum demand periods.

Improper land cultivation, and over-grazing have resulted in extensive soil erosion which has increased the silt load of the Colorado River. Siltation has reduced the capacity of many reservoirs but lack of data makes it impossible to evaluate this damage.

Data on oyster production in the bays along the coast are not sufficient to evaluate the effects of silt or other pollution on oyster production. It is known, however, that production has dropped off considerably in recent years. A major part of this decrease is attributed to the large deposits of silt in the oyster producing area.

BENEFITS RESULTING FROM POLLUTION PREVENTION AND ABATEMENT

Although benefits from pollution abatement measures are difficult to evaluate universal installation of domestic sewage treatment plants in this basin has unquestionably improved health, welfare, property values, and personal enjoyment as well as helped keep the water resources available for new users.

The elimination or reduction of all present and future pollution in the oil producing areas will help safeguard ground and surface water supplies of present and future water users. This will be of particular value in the critical water areas.

Since the clear tributaries in the "Hill Country" area and the many reservoirs of the basin are used extensively for recreation, it is important that these waters be kept free of pollution both from a public health and an aesthetic point of view. Residents of the area will continue to benefit economically from tourist trade, and vacationers will continue to benefit by the enjoyment of desirable recreational waters.

The purchase of the Big Spring, Texas sewage plant effluent by the Cosden Refining Co. for use as an industrial water supply benefits both the city and the industry. The City disposes of the sewage plant effluent and realizes a financial return, while the industry benefits by having a suitable water supply. The possibility of using sewage plant effluents for industrial water supplies should not be overlooked, particularly in critical water areas where conservation is of prime importance.

The reduction of silt pollution from the waters of the basin by soil conservation practices will result in many benefits. Municipalities and industries will benefit by a decreased cost of water treatment, farms and ranches will not suffer the loss of valuable top soil and fertilizer, the cost of dredging navigation channels along the coast will be reduced, and sportsmen will realize more profitable fishing. In addition, reduction in capacity of reservoirs will be minimized by control of soil erosion.

Full evaluation of the benefits from pollution abatement cannot be realized until a study is made of the trend in economic development, of unappropriated waters available, and of the adaptability of the surface waters of the basin for its many uses.

The injection of salt water wastes, produced in the basin's oil fields, back into sub-surface strata has resulted in benefits of great economic and public health importance. This method of disposal has, in many instances, prevented a decrease in oil pressure in producing formations and enabled operators to obtain oil and gas which would normally be lost or economically unfeasible to produce. The primary purpose of this operation is to provide a satisfactory means of disposal for this type of waste -- preventing:

(1) extensive contamination of land surfaces, killing vegetation and timber; and

(2) pollution of basin waters killing aquatic life and rendering the water useless for domestic or industrial uses.

POLLUTION PREVENTION MEASURES IN EFFECT

General

The existing anti-pollution statutes of the two states in which the basin is located, New Mexico and Texas, have proven quite satisfactory according to the officials of the State agencies having water pollution control functions.

The courts of Texas have interpreted their laws to imply that no waste discharged into a watercourse of that State shall be of such a nature as to materially affect the quality of receiving waters. Although there is little, if any, "live-water" in the New Mexico portion of the basin, a high degree of treatment is required by the New Mexico Department of Public Health to protect ground water supplies. These facts have led the state enforcement agencies into following the policy of requiring all wastes to have the lowest possible pollution characteristic when discharged and thus maintaining waters of the highest possible quality throughout the basin.

Laws and Regulations

A brief discussion of the New Mexico and Texas water pollution control laws follows:

New Mexico

The State of New Mexico places the water pollution control program in the State Department of Public Health. In addition, the Department of Game and Fish, the State Engineer, the Interstate Stream Commission, the Oil Conservation Commission, and the Plumbing Administrative Board all have statutes, regulations or codes that have some degree of impact on the control of water pollution. New Mexico does not have a separate water pollution control act directed to the prevention, abatement, and control of pollution of the waters of the State in the light of all legitimate uses of such waters. However, the broad coverage by the statutes and regulations of the Department of Public Health, and the controls by other State Agencies, have proven to be adequate. The State Engineer is given general supervision of the waters of the State and the measurement, appropriation and distribution thereof.

The State Department of Public Health has been designated the State Water Pollution Agency pursuant to the Federal Water Pollution Control Act.

Texas

In 1913 Texas passed legislation prohibiting the pollution of any "watercourse or other public body of water." The State Board of Health was designated to enforce the provisions of the Act and the State Game and Fish Commission (formerly State Game, Fish, and Oyster Commission) was given permissive jurisdiction in the protection of fish and oysters. The States anti-pollution statutes include injunction features under the civil code as well as assessed fines under the penal code. In 1945 a General Sanitation Law was adopted which established minimum standards of sanitation and health protection measures and gave to the State Department of Health the specific responsibility for establishing necessary rules and regulations and the enforcement thereof.

The State Department of Health has been designated the State Water Pollution Agency pursuant to the Federal Water Pollution Control Act.

Jurisdiction is State-wide and covers pollution of any watercourse or other public body of water from which water is taken for the use of farm livestock or for drinking and domestic purposes. The responsibility for prevention of pollution insofar as health is concerned is confined to the State Board of health. Responsibility is shared with the Game and Fish Commission, insofar as protection of fish and oysters is concerned. The Office of the Attorney General provides any necessary legal action against offenders.

Responsibility is further shared with all home rule cities which have the right to prevent pollution of their public water supply, and with all of the many water improvement and conservation districts, both for surface and sub-surface waters, which districts have the right to establish rules and regulations protecting water resources within the area of the district from pollution.

The State Land Commission is responsible for determining that oil well developments on State owned lands do not pollute surface or sub-surface waters. The enforcement of the Land Commission's rules and regulations is handled by the Game and Fish Commission unless it involves pollution of water used for drinking, domestic purposes or livestock, when the State Health Officer assists in enforcement.

Existing Municipal Treatment Facilities

The water pollution control activities of both the Texas State Department of Health and the New Mexico Department of Public Health have been very effective in securing treatment for domestic sewage. Through the efforts of these agencies, 6 municipalities had provided 7 primary treatment plants which served almost 6,000 persons and 50

municipalities had provided secondary treatment plants which served more than 322,636 persons as of January 1952. There were only two municipalities in the basin which served 4,000 persons with sewers but which did not have treatment plants. The approximate 1950 population of all municipalities served by sewers is over 420,000.

Map No. 2 shows the location of existing municipal sewage treatment facilities which are tabulated in Table C.

Since some of the tributaries in the Edwards Plateau or "Hill Country" area are used extensively for recreation, an effort has been made by State Health Department personnel to keep all sewage plant effluents from the watercourse. At the present time a majority of the plants in this area discharge their wastes to lagoons or dispose of it by land irrigation.

TABLE C

Existing Treatment Facilities

Municipal*
January 1952

Degree of Treatment Provided	Number of Municipalities* Served	Number of Treatment Plants	Population Served
Primary	6 (1)	7	5,600
Secondary	50	50	322,636
No Treatment	2	--	4,000

* Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers or other population centers.

(1) Includes one municipality with both primary and secondary treatment plants and one municipality served with two primary plant.

Existing Industrial Waste Treatment Facilities

In January 1952 an evaluation of the industrial waste problem was not complete in a major portion of the basin. However, it can be stated that industrial waste disposal had not presented a pressing problem. Table D lists 40 industries which were known to produce waste of a polluting nature and did not discharge them to a municipal sewerage system. Thirty were known to be giving their waste some degree of treatment, 4 provided no treatment, and 6 fell in the undetermined category.

Included in the above figures are 25 salt water injection wells, completed since 1947, which satisfactorily disposed of waste from an unknown number of producing oil wells. In addition there were many "holding or evaporation ponds" in operation in both the New Mexico and Texas portions of the basin. Very little brine was being discharged from oil wells in New Mexico.

The salt water discharged to these ponds evaporates, seeps into the ground or is discharged into the streams during high flows when greater dilution is available. Due to the critical supply of both ground and surface water in the Texas salt water-oil producing areas, the Texas water pollution control agencies do not recognize these ponds as a satisfactory means of disposal and desires injection into sub-surface strata. It was estimated that 792,000 gallons of salt water was disposed of daily by injection wells (January 1952).

Map No. 3 designates known existing industrial waste treatment facilities.

The State Department of Health has asked authorities at the Air Force installation at Goodfellow Air Field near San Angelo to eliminate pollution caused by oil and other wastes from the engine repair shops discharged to the storm sewer. The effects of these wastes are not known.

Adequacy and Operation of Treatment Facilities

The maintenance and operation of most of the sewage treatment plants in the basin were such that good effluents were being produced. Table E indicates the adequacy of facilities existing in January 1952 with relation to capacity and operation. Capacity was satisfactory in the case of 37 plants and unsatisfactory in the case of 20 plants. Operation was satisfactory at 42 plants, unsatisfactory at 14 plants, and undetermined at 1 plant. The plants which were of an unsatisfactory capacity needed replacement, additions or enlargement.

TABLE D

Existing Treatment Facilities

Industrial*
January 1952

Type Industry	Number of Plants	Number of Industrial Plants Having: Treatment Facilities	No Treatment Facilities	Undetermined Facilities
Food & Allied	4	4		
Petroleum & Coal	30 **	25 **	2	3
Chemical & Allied	3			3
Mining	2	1	1	
Misc.	1		1	

* Industries having separate outlets discharging wastes directly to watercourse.

** Includes 25 salt water injection wells disposing of oil field waste from an unknown number of oil wells.

TABLE E

Adequacy of Existing Treatment Facilities

Municipal*
January 1952

Number of Municipal* Treatment Facilities	Adequacy With Relation to:					
	Capacity			Operation		
	Satis.	Unsat.	Undet'd.	Satis.	Unsat.	Undet'd
57	37	20	---	42	14	1

* Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers or other population centers.

Table F shows the adequacy of known existing industrial treatment facilities. There are five industries which provided treatment for their wastes before discharging them to the watercourse. In each case the adequacy with relation to capacity and operation was undetermined. Also 25 injection wells used for the disposal of brine oil-field wastes were included in this table.

Silt Control Measures

A large portion of the watershed is covered by soil conservation districts which helps farmers and ranchers apply conservation measures to the land. One of the primary objectives of this program is the reduction of erosion with the resultant reduction of sediment damages.

Recent Construction

Within this basin the need for municipal sewage treatment facilities has been met to a high degree. As shown in Table G from 1946 until January 1952, twenty-one (two in New Mexico) new or replacement plants with a total design population of almost 207,000 were completed.

There are no known industrial wastes treatment plants which were completed during the above mentioned period except the 25 salt water injection wells which were placed in operation.

TABLE F

Adequacy of Existing Treatment Facilities

Industrial*
January 1952

No. of Industrial* Treatment Facilities	Adequacy With Relation To:					
	Capacity			Operation		
	Satis.	Unsat.	Undet'd	Satis	Unsat.	Undet'd
30 **			30 **			30 **

* Industries having separate outlets discharging wastes directly to watercourse.

** Includes 25 salt water injection wells, but data does not permit an evaluation of the operation or capacity of these facilities.

TABLE G

Progress in Construction of Pollution

Abatement Facilities
January 1952

Year	Municipal		Industrial	
	Sewage Treatment Plants Completed	Design Population	Waste Treatment Plants Completed	Amt. of Waste Treated (P.E.)
1946				
1947	1	3,000	1*	Not applicable
1948	5	40,200	3*	" "
1949	2	87,000	2*	" "
1950	5	39,700	6*	" "
1951	6	14,000	13*	" "
Jan. 1952	2	23,000	--	---

* These figures represent 25 salt water disposal wells which have been placed in operation since 1947.

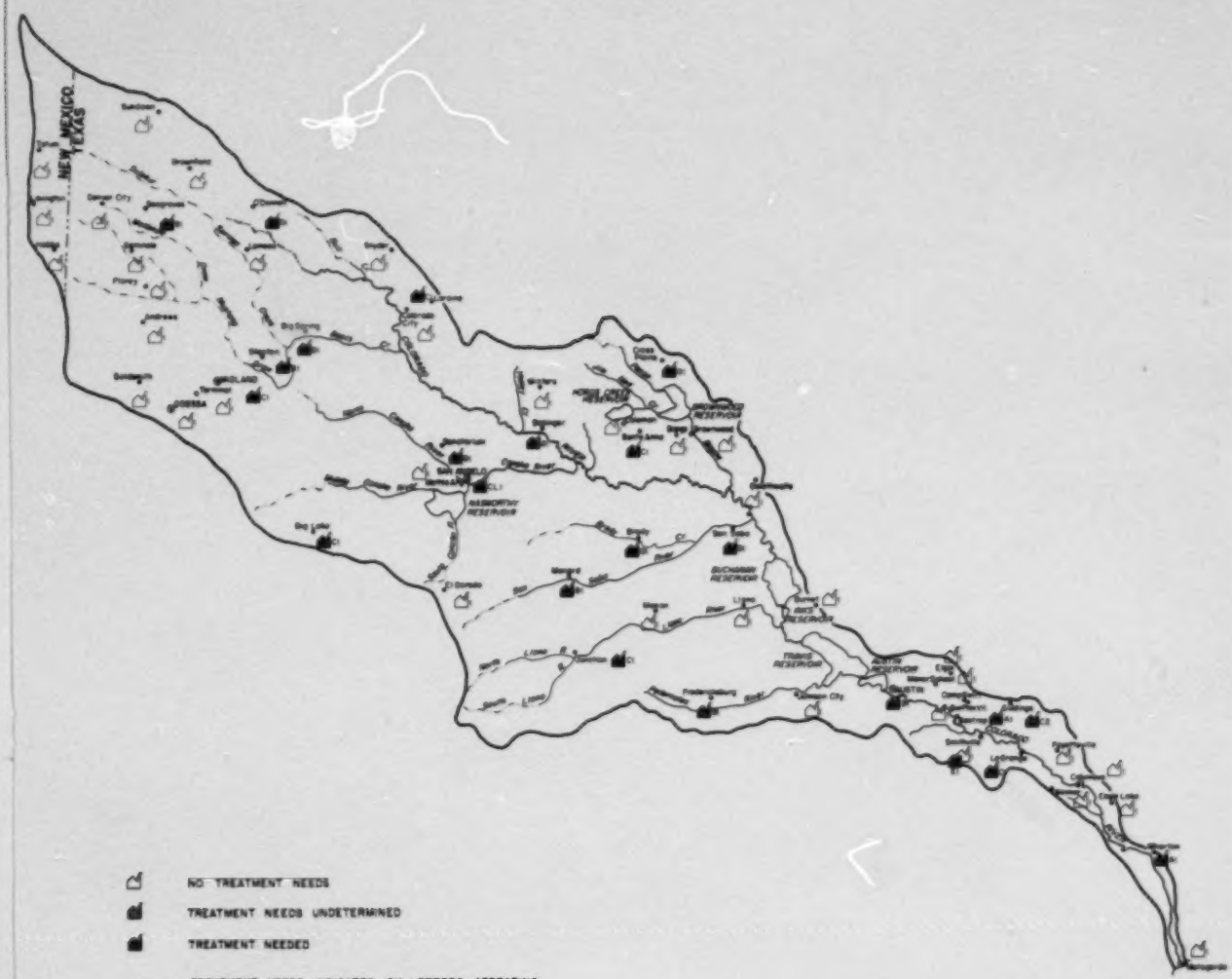
POLLUTION PREVENTION MEASURES REQUIRED
(As Of January 1952)

To properly control sources of pollution caused by municipal sewage the State Water Pollution Control agencies recommended (as indicated in Tables H and L) that new plants be provided at Bastrop and Wharton; that the existing plants be replaced at Big Lake, Giddings, Junction, La Grange, Loraine, Midland, O'Donnell, and Santa Anna; that additions or enlargements be made at Austin, Ballinger, Big Spring, Brady, Cross Plains, Fredericksburg, Menard, O'Donnell, San Angelo, Sanatorium, San Saba, Seagraves, and Stanton; and that a privately owned septic tank at Smithville be abandoned and the system connected to the city-owned sewerage system. All of these recommended improvements were in Texas. No project was required at 33 municipalities. Map No. 4 indicates these municipal waste treatment needs for the basin.

The construction cost of providing these needed improvements is estimated to be about $880,000. This estimate, based on known needs, is for capital expenditures only. It does not include costs of land, right of way, collecting sewers, intercepting sewers, etc., nor does it take into account maintenance and operating costs. It should be kept in mind that these improvements range from minor additions to complete replacement of existing facilities.

It is of interest to note that the per capita cost of a plant which provides secondary sewage treatment (about 85 to 90 per cent removal of polluting material) is usually less than #30.00. However, based on modern methods of financing and assuming the plant useful for a 30 year period, the cost to each person would be only $1.34 annually.

The Air Force installation at Bergstrom Field near Austin has had a substantial increase in personnel. Under the present arrangement sewage is pumped from the base to the Austin city sewerage system. With the increase in personnel it will be necessary to build a treatment plant to serve the installation or enlarge the present sewer connection to Austin. The Texas State Department of Health recommended that the present sewer be enlarged so that the sewage can be continued to be treated at the Austin treatment plant.



NO TREATMENT NEEDS

TREATMENT NEEDS UNDETERMINED

TREATMENT NEEDED

TREATMENT NEEDS INDICATED BY LETTERS APPEARING BESIDE 'TREATMENT NEEDED' SYMBOLS AS FOLLOWS:

- A NEW PLANT
- B ENLARGEMENTS OR ADDITIONS TO EXISTING PLANT
- C REPLACE EXISTING PLANT
- CL CHLORINATION
- E ABANDON PLANT AND CONNECT TO OTHER SYSTEM

NOTE- Number next to symbols or next to code letters represent number of treatment needs in the category designated.

COLORADO RIVER BASIN
LOCATION MAP

38-A

SCALE OF MILES
0 5 0 10 20 30 40 50

COLORADO RIVER BASIN

MUNICIPAL WASTE TREATMENT NEEDS

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP NO. 4

TABLE H

Waste, Treatment Needs - Municipal*
January 1952

Needs	Number	Population Served by Facilities
New Plant	2	4,000
Enlargement or Additions to Existing Plant	13 (1)	193,400
Replace Existing Plant	9 (2)	24,280
No Project Required	35 (3)	110,556
Undetermined	--	---

* Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers or other population centers.

(1) Includes one plant which needs chlorination only.

(2) Includes one privately owned septic tank (serving 1,600) which should be abandoned and connected to city sewerage system and one municipality served by two unsatisfactory primary treatment plants.

(3) Includes a new sewerage system for which the population served is undetermined.

Tables I and L indicate the needs for industrial waste pollution abatement as of January 1952. Two industries needed treatment plants, one industry required no treatment, and 37 industries had undetermined needs. Also included in Table I are the 25 salt water injection wells which fell in the undetermined category. It is not known how many additional facilities were needed to adequately control the disposal of salt water wastes.

Salt water and oil wastes from oil wells should be kept from the waters of the basin, particularly in critical water areas where present and future water uses might be impaired. These wastes should be recharged into the ground by injection wells or disposed of by other adequately regulated measures to protect ground and surface waters.

Map No. 5 indicates the basin's industrial pollution abatement needs.

To control the pollution caused by silt, soil erosion control measures should be intensified throughout the basin. These measures include dams, terraces, contour farming, reforestation, pasture land control, and crop rotation.

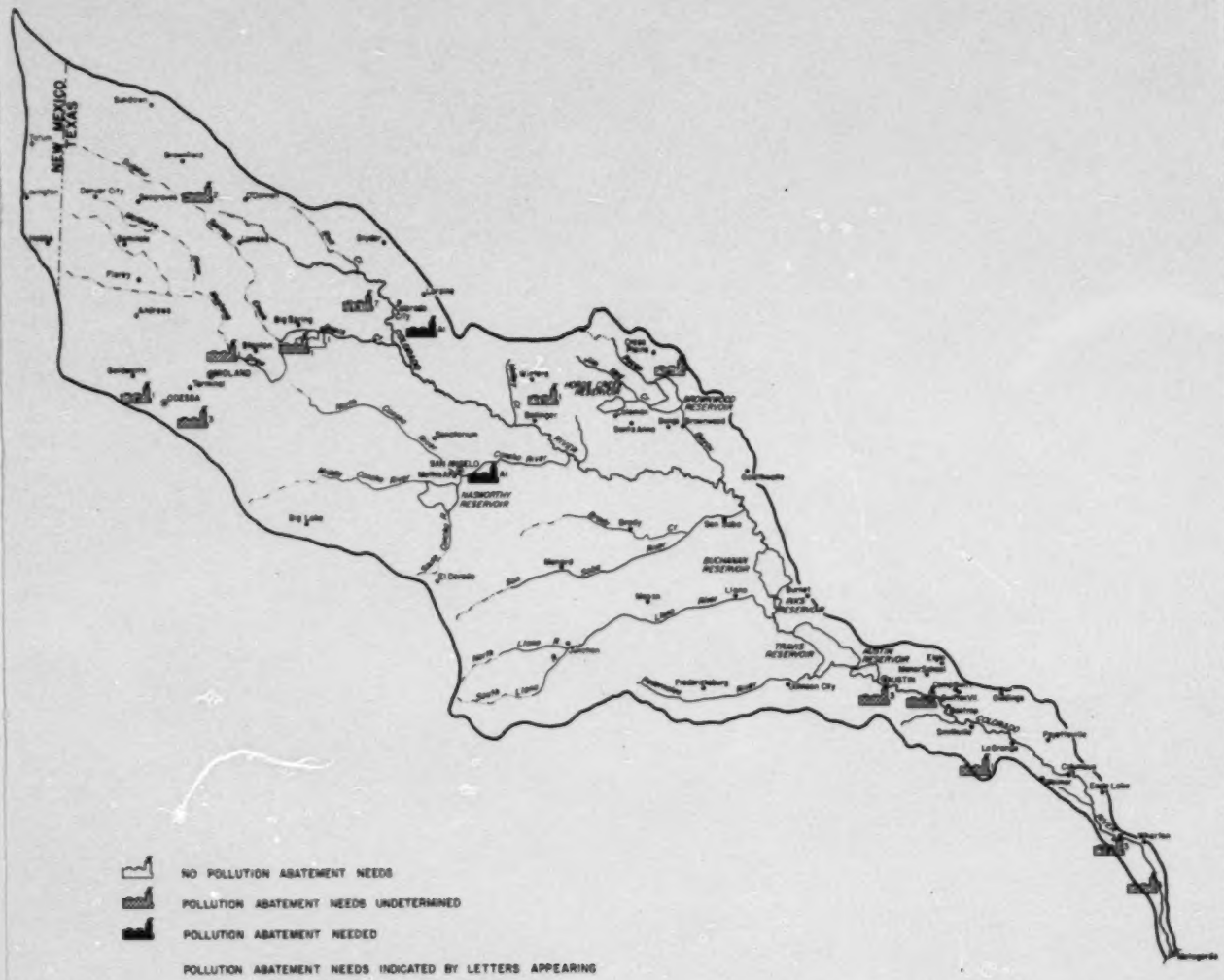
TABLE I

Industrial* Waste Pollution Abatement Needs
January 1952

Needs	Number
New Plant	2
Enlargement or Additions to Existing Plant	
Replace Plant	
Connection to Municipal Sewer System	
No Project Required	1
Undetermined	37 **

* Industries having separate outlets discharging wastes directly to watercourse.

** Includes 25 salt water injection wells disposing of oil field wastes from an unknown number of oil wells. The adequacy of these facilities is undetermined.



NO POLLUTION ABATEMENT NEEDS

POLLUTION ABATEMENT NEEDS UNDETERMINED

POLLUTION ABATEMENT NEEDED

POLLUTION ABATEMENT NEEDS INDICATED BY LETTERS APPEARING BESIDE 'POLLUTION ABATEMENT NEEDED' SYMBOLS, AS FOLLOWS:

A NEW PLANT OR OTHER POLLUTION CONTROL MEASURES

NOTE-

Numbers next to symbols or next to code letters represent number of pollution abatement needs in the category designated.

SWI inside symbols designates salt water injection wells.

40-A

SCALE OF MILES
0 5 0 10 20 30 40 50

COLORADO RIVER BASIN
INDUSTRIAL
POLLUTION ABATEMENT NEEDS

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP NO. 5

Table J shows the January 1952 status of municipal action on pollution abatement needs. Twelve municipalities had taken no action; nine municipalities were actively planning improvements and had either hired a consulting engineer or taken steps to raise the necessary funds; and three municipalities had treatment plants under construction.

Table K indicates that the two industries for which the pollution abatement needs were known were not actively planning improvements.

TABLE J

Reproduced from best available copy.

Current Status of Municipal* Action On

Pollution Abatement Needs
January 1952

Status of Action	Number of Municipalities*
Inactive	12 (1)
Active Planning	9 (2)
Final Plans Approved	
Under Construction	3
Undetermined	

* Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers or other population centers.

(1) Includes two municipalities with treatment plants of satisfactory capacity, but need additions.

(2) Includes a municipality which needs to replace two primary treatment plants.

TABLE K

Current Status of Industrial* Action on

Pollution Abatement Needs

January 1952

Status of Action	Number of Industries*
Inactive	2
Active Planning	
Final Plan Approved	
Under Construction	
Undetermined	

* Industries having separate outlets discharging wastes directly to watercourse.

TABLE L

Municipalities and Industries Needing
Improvements for Abatement of Pollution

Date January 1952

Name and Location (All in Texas)	Population* Served	Improvements Needed	Remarks
Austin	125,000	Enlargement	Active Planning
Carnation Milk Co.	Undet'd	Undet'd	
National By-Products Co.	Undet'd	Undet'd	
Wallace Cannery	Undet'd	Undet'd	
Ballinger	2,000	Addition	
Bastrop	1,400	New Plant	Active Planning
Big Lake	1,000	Replacement	
Big Spring	15,000	Enlargement	Under Const.
Cosden Petroleum Corp.	Undet'd	Undet'd	
Brady	5,800	Enlargement	
Camp Swift			
Texas Rendering Co.	Undet'd	Undet'd	
Colorado City			
Col-Tex Refining Co.	Undet'd	New Plant	
Cross Plains	1,200	Addition	
Fredericksburg	3,900	Enlargement	
Giddings (2 plants)	1,200	Replacement	Active Planning
Junction	1,430	Replacement	Under Const.
La Grange	2,200	Replacement	Active Planning
L. W. Stolz Memorials	--	Undet'd	Wash Water
Loraine	500	Replacement	
Menard	400	Enlargement & Addition	Active Planning
Midland	15,000	Replacement	Under Const.
Odessa			
City Service Oil Co.	Undet'd	Undet'd	
Odessa Natural Gasoline Company	Undet'd	Undet'd	
United Carbon Co.	Undet'd	Undet'd	
O'Donnell	700	Addition	
San Angelo	33,200	Chlorination	Active Planning
Goodfellow Field Engine Repair Shop	Undet'd	New Plant	
Sanatorium	1,000	Enlargement	
San Saba	2,000	Addition	Active Planning
Santa Anna	1,350	Replacement	
Seagraves	2,000	Addition	
Columbian Carbon Co.	Undet'd	Undet'd	
Independent-Eastern Torpedo Co.	Undet'd	Undet'd	

TABLE L (continued)

Name and Location (All in Texas)	Population* Served	Improvements Needed	Remarks
Smithville	1,600	Abandon Plant	Actively planning to abandon plant and connect to municipal treatment plant
Stanton	1,200	Addition	
DuPont, E.I.,de Nemours Co.	Undet'd	Undet'd	
Wharton	2,600	New Plant	

* For industries the organic waste load is expressed as population equivalent as measured by B.O.D.

APPENDIX I
Table 1
BASIC DATA ON SOURCES OF MUNICIPAL* POLLUTION
COLORADO RIVER BASIN
January 1952

Name and Location (Located in Texas unless noted Otherwise)	Mile Above Mouth Outlet Stream	Population Served By Sewers	P.E. (B.O.D.) Untreated Waste**	Waste Treatment Provided	Adequacy of Treatment Facilities		P.E. (B.O.D.) of Plant Effluent	Treatment Needs	Current Status of Municipal* Action
					Cap'y	Opr.			
COLORADO RIVER									
Colorado City	C-795	6,500	(6,500)	secondary	sat.	sat.	(975)	none	
Beals Creek	C-770								
Big Spring	B-43	15,000	10,430	secondary	unsat.	sat.	750(4)	enlargement	under const.
Terminal	--	1,500	(1,500)	secondary	sat.	sat.	(225)	none	
Ballinger	C-652	2,000	2,600	secondary	sat.	sat.	236	addition	inactive
Concho River	C-629								
Pecan Bayou	C-512								
Brownwood	P-33	15,000	18,500	secondary	sat.	sat.	2,750	none	
San Saba River	C-480								
Menard	S-113	400	(400)	primary	unsat.	unsat.	(400)	enlargement & Addition	active planning
Llano River	C-400								
Llano	L-23	750	430	secondary	sat.	sat.	115	none	
Austin	C-290	125,000	119,000	secondary	unsat.	sat.	39,000	enlargement	active planning
Gilleand Creek	--								
Manor School	--	236	30	secondary	sat.	unsat.	5	none	
Big Sandy Creek	C-245								
Bastrop	C-237	1,400	(1,400)	none	--	--	(1,400)	new plant	active planning
Smithville	C-213	1,600	(1,600)	primary	unsat.	unsat.	(960)	abandon plant	active planning(7)
Gassley Creek	C-212								
Smithville	G-1	1,000	(1,000)	secondary	sat.	sat.	(50)	none	
Rabbs Creek	C-186								
Giddings	R-15	600	(600)	primary	unsat.	unsat.	(420)	replacement	active planning

APPENDIX I (continued)

Name and Location (Located in Texas unless noted Otherwise)	Mile Above Mouth Outlet Stream	Population Served By Sewers	P.E. (B.O.D.) Untreated Waste**	Waste Treatment Provided	Adequacy of Treatment Facilities		P.E. (B.O.D.) of Plant Effluent	Treatment Needs	Current Status of Municipal * Action
					Cap'y	Opr.			
Giddings (Brazos R. Drainage)	—	600	(600)	primary	unsat.	unsat.	(420)	replace-ment	active planning
La Grange	C-174	2,200	(2,200)	secondary	unsat.	unsat.	(1,760)	replace-ment	active planning
Cummins Creek	C-138								
Columbus	C-135	1,800	(1,800)	secondary	sat.	sat.	(360)	none	
Wharton	C-66	2,600	(2,600)	none	--	--	(2,600)	new plant	inactive
CONCHO RIVER									
South Concho River	C-61								
North Concho River	C-61								
San Angelo	C-61	33,200	32,000	secondary	sat.	sat.	720(2)(3)	chlorination	act. planning
SOUTH CONCHO RIVER									
Middle Concho River									
Big Jim Creek									
Big Lake		1,000	(1,000)	primary	unsat.	unsat.	(800)	replace-ment	inactive
BIG SANDY CREEK									
Town Branch	B-6								
Elgin	T-9	2,750	(2,750)	secondary	sat.	sat.	(275)	none	
CUMMINS CREEK									
Pools Branch	C-17								
Fayetteville	P-4	450	(450)	secondary	sat.	unsat.	(360)	none	
IRRIGATION, LAGOONS, OR DRY LAKE (Effluents do not reach flowing stream)									
Andrews		2,100	(2,100)	secondary	sat.	sat.	0(2)	none	
Bangs		1,200	(1,200)	secondary	sat.	sat.	0(5)	none	
Brady		5,800	3,250	secondary	unsat.	sat.	0(1)(2)	enlarge-ment	inactive

APPENDIX I (continued)

Name and Location (Located in Texas unless noted Otherwise)	Mile Above Mouth Outlet Stream	Population Served By Sewers	P.E. (B.O.D.) Untreated Waste**	Waste Treatment Provided	Adequacy of Treatment Facilities		P.E. (B.O.D.) of Plant Effluent	Treatment Needs	Current Status of Municipal* Action
					Cap'y.	Opr.			
Brownfield		8,600	(8,600)	secondary	sat.	sat.	0(1)(2)	none	
Burnet		500	522	secondary	sat.	sat.	0(1)(2)	none	
Coleman		5,000	4,050	secondary	sat.	sat.	0(1)(2)	none	
Cross Plains		1,200	(1,200)	secondary	unsat.	sat.	0(1)(2)	addition	inactive
Denver City		1,500	(1,500)	secondary	sat.	sat.	0(1)(6)	none	
Eagle Lake		2,200	(2,200)	secondary	sat.	sat.	0(1)(2)	none	
El Dorado		650	300	secondary	sat.	sat.	0(1)	none	
Florey		150	(150)	secondary	sat.	sat.	0(2)	none	
Fredericksburg		3,900	2,280	secondary	unsat.	sat.	0(1)(2)	enlargement	inactive
Goldthwaite		1,000	675	secondary	sat.	sat.	0(2)	none	
Gulf Refinery Housing Area (Goldsmith)		500	(100)	secondary	sat.	sat.	0(2)	none	
Hobbs, New Mexico		11,000	(11,000)	secondary	sat.	sat.	0(1)	none	
Johnson City		600	(600)	secondary	sat.	sat.	0(2)	none	
Junction		1,430	660	secondary	unsat.	sat.	0(1)(2)	replacement	under const.
Lamesa		8,500	(8,500)	secondary	sat.	sat.	0(1)(2)	none	
Loraine		500	(500)	secondary	unsat.	unsat.	0(6)	replacement	inactive
Lovington, New Mexico		3,000	(3,000)	secondary	sat.	sat.	0(1)	none	
Mason		1,070	585	secondary	sat.	sat.	0(2)(5)	none	
Mathis Air Field		100	(100)	secondary	sat.	sat.	0(2)	none	
Midland		15,000	(15,000)	secondary	unsat.	unsat.	0(2)	replacement	under const.
Odessa		20,000	(20,000)	secondary	sat.	sat.	0(1)(2)	none	
O'Donnell		700	(700)	secondary	unsat.	unsat.	0(1)(6)	addition	inactive
Sanatorium		1,000	(1,000)	secondary	unsat.	unsat.	0(1)(2)	enlargement	inactive
San Saba		2,000	792	secondary	unsat.	sat.	0(1)(2)	addition	active planning
Santa Anna		1,350	(1,350)	secondary	unsat.	sat.	0(1)	replacement	inactive
Seagraves		2,000	(2,000)	secondary	unsat.	sat.	0(1)	addition	inactive
Seminole		3,200	(3,200)	secondary	sat.	sat.	0(1)	none	

APPENDIX I (continued)

Name and Location (Located in Texas unless noted otherwise)	Mile Above Mouth Outlet Stream	Population Served by Sewers	P.E. (B.O.D.) Untreated Waste**	Waste Treatment Provided	Adequacy of Treatment Facilities		P.E. (B.O.D.) of Plant Effluent	Treatment Needs	Current Status of Municipal* Action
					Cap'y.	Opr.			
Snyder		6,000	(6,000)	secondary	sat.	sat.	0(1)(2)	none	
Stanton		1,200	(1,200)	primary	unsat.	unsat.	0(1)	addition	inactive
Sundown		undet'd	undet'd	secondary	sat.	undet'd	0(2)	none	
Swiftex Village		250	(250)	secondary	sat.	sat.	0(1)	none	
Tatum, New Mexico		450	450	secondary	sat.	sat.	0(2)	none	
Weimar		1,000	(1,000)	secondary	sat.	sat.	0(2)	none	
Winters		2,200	830	secondary	sat.	unsat.	0(1)(2)	none	
TIDEWATER									
Colorado River									
Texas Gulf Sulfur									
Summer Camp (Matagorda)		200	(200)	primary	sat.	sat.	undet'd	none	

* Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers or other population centers.

**Includes industrial wastes discharged into municipal sewerage systems. P.E. (Population Equivalent) of raw wastes is reported as population served or is calculated from actual pounds of BOD in wastes divided by .167 -- the pounds of BOD produced by one person per day. P.E. of plant effluent is calculated from the P.E. of raw waste and actual or estimated plant efficiencies. P.E.'s in parenthesis are estimates.

(1) Effluent used for irrigation.
(2) Effluent goes to lagoons.
(3) Part of effluent to irrigation.
(4) Effluent sold to Cosden Refinery.
(5) Effluent to dry arroyo.
(6) Effluent drains to dry lake.
(7) Abatement of pollution by privately owned septic tank has been ordered.

APPENDIX I
TABLE 2
BASIC DATA ON SOURCES OF INDUSTRIAL* POLLUTION
COLORADO (OF TEXAS) RIVER BASIN
January 1952

Name and Location (All in Texas)	River Mile Above Mouth Outlet Stream	Type Industry	Type Waste Produced	Treatment or Other Pollution Control Measures			P. E. (BOD) Disch'd to Watercourse	Pollution Abatement Needs	Current Status of Industrial* Action
				Degree	Adequacy Cap'y	Adequacy Opr.			
COLORADO RIVER									
#Columbian Carbon Co. Seagraves		chemical	undet'd	undet'd	undet'd	undet'd	undet'd	undet'd	
#Independent-Eastern Torpedo Co. Seagraves		chemical	undet'd	undet'd	undet'd	undet'd	undet'd	undet'd	
Cactus Sand & Gravel Co. Big Spring	C-798	mining	inorganic	none	--	--	none	none	
Coltex Refining Co. Colorado City	C-796	petroleum	organic & inorganic	none	--	--	undet'd	new plant	inactive
Beals Creek	C-770								
#City Service Oil Co. Odessa	--	petroleum	organic & inorganic	undet'd	undet'd	undet'd	undet'd	undet'd	
#Odessa Natural Gasoline Co. Odessa	--	Petroleum	organic & inorganic	undet'd	undet'd	undet'd	undet'd	undet'd	
#United Carbon Co. Odessa	--	petroleum	undet'd	undet'd	undet'd	undet'd	undet'd	undet'd	
#E.I.DuPont de Nemours Co. Stanton	--	chemical	undet'd	undet'd	undet'd	undet'd	undet'd	undet'd	

APPENDIX I
TABLE 2
BASIN DATA ON SOURCES OF INDUSTRIAL* POLLUTION
COLORADO (OF TEXAS) RIVER BASIN
January 1952

Name and Location (All in Texas)	River Mile Above Mouth Outlet Stream	Type Industry	Type Waste Produced	Treatment or Other Pollution Control Measures			P. E. (BOD) Disch'd to Watercourse	Pollution Abatement Needs	Current Status Industrial* Action
				Degree	Adequacy Cap'y	Adequacy Opr.			
Cosden Petroleum Corp.									
Big Spring	B-43	petroleum	org&inorg	none	--	--	undet'd	undet'd	
CONCHO RIVER	C-629								
Goodfellow Air Field Engine Repair Shop									
San Angelo	C-61	misc.	undet'd	none	--	--	undet'd	new plant	inactive
Nat'l By-Products Co.									
Austin	C-290	food & allied	organic	second'y	undet'd	undet'd	O##	undet'd	
Carnation Milk Co.									
Austin	C-290	food & allied	organic	second'y	undet'd	undet'd	O##	undet'd	
Wallace Cannery									
Austin	C-290	food & allied	organic	second'y	undet'd	undet'd	O##	undet'd	
Piney Creek	C-238								
Tex. Rendering Co.									
Camp Swift	P-6	food & allied	organic	minor	undet'd	undet'd	undet'd	undet'd	
L. W. Stolz Memorials									
La Grange	C-174	mining	inorganic	minor	undet'd	undet'd	none	undet'd	

* Industries having separate outlets and discharging wastes directly to watercourse.
\# Outlet stream undetermined.
Wastes disposed of on land.

NOTE: Table does not include the thousands of producing oil wells in the basin for which no information is available.

Table 2 (Continued)
Industrial Waste Data
Oil Field Salt Water Disposal Wells
Colorado River Basin
January 1952

County and Operator (All in Texas)	Oil Field	Waste Treated Before Injection	Method of Injection	Gallons of Water per Day	Date Well Completed
Borden					
Amerada Petroleum Corp.	E. Vealmoor	No	P	25,000	1951
Seaboard Oil Co.	Good	No	P	21,000	1951
Callahan					
Dill McGinty	County Regular	No	G	2,000	1951
Coleman					
Amerada Petroleum Corp.	County Regular	No	G	4,000	1947
" " "	" "	No	G	6,000	1949
Magnolia Petroleum Co.	" "	No	G	4,000	1948
" " "	" "	No	P	3,000	1950
Manley Bros	" "	No	G	17,000	1950
" "	" "	No	G	8,000	1951
" "	" "	No	G	8,000	1951
Ector					
Shell Oil Co.	TXL Ellenberger	No	P	101,000	1950
Howard					
Magnolia Pet. Co.	Howard-Glasscock	No	P	168,000	1951
Seaboard Oil Co.	Vealmoor	No	G	42,000	1950
Sunray Oil Corp.	Howard-Glasscock	No	P	63,000	1950
Mitchell					
Superior Oil Co.	Dockrey	No	P	8,000	1951
" " "	Dockrey	No	P	6,000	1951
Runnels					
Saxon Oil Co.	Beddo	No	P	7,000	1951
Wharton					
Perry R. Bass	Hutchin-Kubela	No	P	18,000	1948
General Crude	Lane City	No	G	4,000	1950
Humble O & R Co.	Magnet Withers	Yes	G	46,000	1951

TABLE 2 (continued)

County and Operator (All in Texas)	Oil Field	Waste Treated Before Injection	Method of Injection	Gallons of Water per Day	Date Well Completed
Michaux et al	N. Withers	NO	P	63,000	1948
Michaux et al	N. Withers	NO	G	42,000	1951
The Texas Co.	Magnet Withers	NO	G	N	1949
" " "	Pickett-Ridge	Yes	P	84,000	1951
Pierce Withers et al	" "	NO	P	42,000	1951

G--gravity
P--pressure
N--information not available

APPENDIX II
COLORADO (OF TEXAS) RIVER BASIN

WATER SUPPLIES

Municipality or Owner	Water Use	Population Served	Source of Supply	Acre Feet Storage	Acre Feet Granted	Ave. Use Gallons Per Day
TEXAS						
Andrews	Mun.	3,000	Ogallala Form			2,300,000
Austin	(Mun.	150,000	Colorado R.	---	40,000	15,000,000
	(Ind.		Colorado R.	---	416,000	
Ballinger	(Mun.	7,425	Elm Cr.	366	1,424	750,000
	(Mun.		Valley Cr.	4,000	1,000	
Bangs	Mun.	1,120	City of Brownwood			33,000
Bastrop	(Mun.	5,000	Ground			500,000
	(Mun.	---	Colorado R.	---	1,095	176,800
Big Lake	Mun.	2,250	Trinity Sand			300,000
Big Spring	(Mun.		Alluvium			
	(Mun.	16,000	Devil's Cr.	1,458	1,100	1,537,000
	(Mun.		Moss Cr.	2,477	600	
Brady	(Mun.	7,200	Hickory Sandstone			1,110,000
	(Mun.	---	Brady Cr.	690	730	---
Bronte	(Mun.		Alluvium			45,000
	(Mun.	900	E. Kickapoo Cr.	27	27	
	(Mun.		Red Hollow Cr.	141	141	
Brownfield	Mun.	11,000	Ogallala Form.			1,000,000
Brownwood	Mun.	50,000	Pecan Bayou	645	2,121	3,830,000
	Irr.	---	Pecan Bayou	---	67	
Burnet	Mun.	1,480	Ellenberger Group			65,000
Carlsbad	Mun.		Ground			80,000
Christoval	Mun.	160	Trinity Sand			80,000
Coahoma	Mun.	560	Ogallala Form.			500,000
Coleman	(Mun.	9,500	Indian Cr.	2,000	1,120	
	(Mun.		Hords Cr.	7,959	2,240	700,000
Colorado City	(Mun.	9,000	Dockum Group			
	(Mun.	---	Colorado R.	111,000	30,000	none

APPENDIX II (continued)

Municipality or Owner	Water Use	Population Served	Source of Supply	Acre Feet Storage	Acre Feet Granted	Ave. Use Gallons Per Day
Columbus	Mun.	1,600	Alluvium			250,000
Cross Plains	(Mun.	1,460	Ground			170,000
	(Mun.	none	Surface	304	150	none
Denver City	Mun.	3,600	Ogallala Form.			600,000
Eagle Lake	Mun.	2,100	Ground			210,000
Eden	Mun.	1,544	Hickory Sandstone			150,000
Eldorado	Mun.		Fredericksburg Group			150,000
Elgin	Mun.	3,000	Wilcox Group			700,000
Fayetteville	Mun.	550	Oakville Sandstone			200,000
Fredericksburg	Mun.	3,210	Ellengerger Group			200,000
Giddings	Mun.	1,800	Ground			200,000
Goldthwaite	Mun.	1,700	Trinity Sand			150,000
Johnson City	Mun.	---	Ground			---
Junction	(Mun.	2,100	Ground			300,000
	(Ind.	---	S. Llano R.		361,000	(to be returned)
La Grange	(Mun.	2,500	Ground			110,000
	(Mun.	none	Colorado R.	---	330	none
Lamesa	Mun.	11,000	Ogallala Form.			1,500,000
Llano	Mun.	3,890	Llano R.	197	500	300,000
Loraine	Mun.	1,000	Ground			170,000
Marble Falls	Mun.	1,200	Colorado R.			100,000
Mason	Mun.	---	Ground			---
Matagorda	Mun.	---	Ground			40,000
Melvin	Mun.	950	Alluvium Deposits			60,000
Menard	(Mun.	none	San Saba R.	---	280	none
	(Mun.	3,200	Ground			200,000
Midland	Mun.	19,000	Ogallala Form.			2,000,000
Miles	Mun.	832	Clearfork Cr.			100,000
Odessa	Mun.	25,000	Trinity Sand			1,500,000
O'Donnell	Mun.	1,200	Ogallala Form.			150,000
Ovalo	Mun.	160	Alluvium Deposits			20,000
Paint Rock	Mun.	400	Concho R.			40,000
Pflugerville	Mun.	340	Edwards Limestone			22,000
Richland Sprs.	Mun.	560	Springs			35,000
Robert Lee	(Mun.	800	Alluvium			40,000

APPENDIX II (continued)

Municipality or Owner	Water Use	Population Served	Source of Supply	Acre Feet Storage	Acre Feet Granted	Ave. Use Gallons Per Day
Robert Lee	(Mun.	none	Surface	---	42	none
Rowena	Mun.	---	Ground			60,000
San Angelo	Mun.	50,000	Concho R.			7,000,000
San Saba	(Mun.	2,600	Springs			720,000
	(Mun.		San Saba R.		5,854	100,000
Sanitorium	Mun.	1,350	Alluvium			300,000
Santa Anna	Mun.	2,650	Lake Sealy & San-tana			135,000
Seagraves	Mun.	3,500	Ogallala Form.			330,000
Seminole	Mun.	5,100	Trinity Sand			900,000
Smithville	(Mun.	4,000	Carrizo Sand			500,000
	(Mun.	none	Colorado R.	---	450	none
Snyder	Mun.	8,000	Alluvium Deposits or Dockum Group			1,000,000
Stanton	Mun.	1,700	Ogallala Form.			120,000
Texon	Mun.	5,000	Bolson Deposits			140,000
Wharton	Mun.	6,000	Ground			540,000
Whiteface	Mun.	800	Ground			80,000
Winters	(Mun.	3,000	Elm Cr.	2,673	560	250,000
	(Mun.		Adams Draw	255	2,896	
NEW MEXICO						
Hobbs	Mun.	14,000	Ground		5,500	1,750,000
Lovington	Mun.	3,500	Ground		2,091	350,000
TEXAS						
Brown County WID # 1	Dom. & Mun.		Pecan Bayou-Jim Ned Cr.	---	---	3,375,000
Upper Colo. R. Authority	Dom. & Mun.		Basin	950	40,250	none
W. Tex. Util. Co.	Dom. & Mun.		Concho R.	616	7,500	none
5 Misc. Approp.	Dom. & Mun.		Basin	1,202	2,094	538,000
G.C. & S.F. RyCo.	Ind.		Basin	2,219	8,793	196,000
W. Tex. Util. Co.	Ind.		Concho R.	12,500	25,000	---
MKT Ry. Co.	Ind.		Basin	---	1,020	11,600
TP Ry. Co.	Ind.		Unnamed Cr.	---	1,350	16,400
Tex. Elec. Co.	Ind.		Morgan Cr.	30,200	5,500	unknown

APPENDIX II (continued)

Municipality or Owner	Water Use	Population Served	Source of Supply	Acre Feet Storage	Acre Feet Granted	Ave. Use Gallons Per Day
7 Misc. Approp.	Ind.		Basin	385	1,082	115,000
U.S. Fish & Wildlife Ser.	Hatchery		Basin	1,160	3,500	1,164,000
LCRA	Hydro-Elec.		Colorado R.	5,703,810	6,594,240	2,237,000,000
"	Hydro-Elec.		San Saba R.	161,000	72,400	---
"	Hydro-Elec.		Llano R.	---	218,000	54,000,000
Cent. Power & Light Co.	Hydro-Elec.		Colorado R.	3,818	579,000	none
4 Misc. Approp.	Mining		Basin	636	349	73,200
3 Misc. Approp.	Recreation		Basin	268	364	66,900
Gulf Coast Water Co.	Irr.		Colorado (Incl. in LCRA approp. to irr. 375,000a.) (Amt. used - 161,071 AF for 42,104a.)			
UCRA	Irr.		Colorado R.	670,000	116,000	none
UCRA	Irr.		N. Concho R.	391,500	80,400	under const.
Garwood Irr. Co.	Irr.		Colorado (Inc. in LCRA Approp. to irr. 65,000a.) (Amt. used 61,480 AF for 24,592a.)			
Blue Creek Canal Co.	Irr.		Blue Creek		9,800	none
Lakeside Irr. Co.	Irr.		Colorado R.	9,600	10,000	(LCRA approp.)
Menard Irr. Co.	Irr.		San Saba R.	none	3,480	---
W. Tex. Util. Co.	Irr.		Concho R.	13,229	18,060	---
Brown County WID # 1	Irr.		Pecan Bayou & Jim Ned Cr.	125,000	16,800	2,320,000
A. H. Pierce Est.	Irr.		Colorado R.	none	60,000	40,000,000
San Jose Irr. & Power Co.	Irr.		Dove Cr.	none	3,560	---
A. D. Bolm	Irr.		Colorado R.	none	2,230	892,000
C. W. Ketham	Irr.		San Saba R.	none	2,174	26,760
B. H. Helwig & A. W. Miles	Irr.		Concho R.	---	1,800	---

APPENDIX II (continued)

Municipality or Owner	Water Use	Population Served	Source of Supply	Acre Feet		Ave. Use Gallons Per Day
				Storage	Granted	
Z. L. Scott	Irr.		Onion Cr.	none	1,600	none
Motl Heirs	Irr.		Spring Cr.	750	1,460	---
A. W. Jeschke	Irr.		Concho R.	700	1,400	20,500
W. A. Guinn	Irr.		Dove Cr.	242	1,300	---
Blue Cr. Ranch Co.	Irr.		Dry Cr.	---	1,200	none
E. H. Crawford	Irr.		Colorado R.	150	1,200	none
J. H. Wood	Irr.		San Saba R.	---	1,000	none
F. O. Graham	Irr.		Bolger Cr.	870	1,000	---
H. R. Fichburg	Irr.		Dove Cr.	---	1,000	1,865,000
F. Tankersley	Irr.		Spring Cr.	---	1,000	29,700
379 Misc. Approp.	Irr.		Basin	15,719	55,010	6,450,000

APPENDIX III
POPULATION TREND AND DISTRIBUTION
COLORADO RIVER BASIN

County	Area in Basin (sq. mi.)	Population in Basin			Percentage Increase		1950 Population	
		1930	1940	1950	1940 over 1930	1950 over 1940	Urban	Rural
New Mexico								
Lea	1,535	4,308	14,834	21,265	244	43	16,198	4,347
Roosevelt	498	1,371	1,795	2,023	33	13		2,023
Texas								
Andrews	1,480	733	1,271	4,980	73	292	3,294	1,686
Bastrop	799	22,892	20,709	18,804	-10	-9	9,723	9,081
Blanco	578	2,583	2,866	2,541	9	-11		2,541
Borden	902	1,489	1,381	1,094	-7	-21		1,094
Brown	919	26,213	25,758	28,425	-2	10	20,181	8,244
Burnet	525	6,983	7,264	6,984	4	-4		6,984
Caldwell	80	2,553	2,024	1,573	-22	-22		1,573
Callahan	392	4,971	4,498	3,533	-9	-21		3,533
Cochran	424	780	1,485	2,357	90	45		2,357
Coke	915	5,253	4,590	4,045	-13	-12		4,045
Coleman	1,282	23,669	20,571	15,503	-13	-25	6,530	8,973
Colorado	494	12,290	11,444	11,292	-7	-1	5,665	5,627
Comanche	31	306	319	258	4	-19		258
Concho	1,004	7,645	6,192	5,078	-19	-18		5,078
Crockett	60	16	17	24	6	41		24
Dawson	899	13,573	15,367	19,113	13	24	10,704	8,409
Eastland	46	847	753	594	-11	-21		594
Ector	608	3,555	13,520	37,819	280	180	29,495	8,324
Edwards	628	375	397	394	29	0		394
Fayette	706	21,588	20,560	16,995	-5	-17	2,739	14,256
Gaines	1,479	2,800	8,136	8,909	191	9	3,479	5,430
Gillespie	1,026	10,851	10,507	10,359	-3	-1	3,854	6,505
Glasscock	864	1,263	1,193	1,089	-6	-9		1,089
Hays	288	2,771	2,852	3,315	3	16		3,315
Hockley	309	2,040	2,785	4,478	48	61		4,478
Howard	912	22,888	20,990	26,722	-8	27	17,288	9,434

APPENDIX III (continued)

County	Area in Basin (sq. mi.)	Population in Basin			Percentage Increase		1950 Population	
		1930	1940	1950	1940 over 1930	1950 over 1940	Urban	Rural
Irion	1,073	2,049	1,963	1,590	-4	-24		1,590
Kendall	47	147	150	160	2	7		160
Kerr	142	444	509	613	14	20		613
Kimble	1,274	4,199	5,064	4,619	23	-9		4,619
Lampasas	155	692	732	792	6	8		792
Lee	112	4,867	4,635	3,687	-5	-20	2,532	1,155
Llano	947	5,538	5,996	5,377	8	-10	2,954	2,423
Lynn	303	3,924	3,785	3,499	-4	-8		3,499
Martin	911	5,785	5,556	5,541	-4	0		5,541
Mason	935	5,511	5,378	4,945	-2	-8		4,945
Matagorda	193	1,734	1,968	2,116	13	7		2,116
McCulloch	1,066	13,883	13,208	11,701	-5	11	5,944	5,757
Menard	914	4,447	4,521	4,175	2	- 8	2,685	1,490
Midland	931	7,995	11,705	25,751	46	120	21,710	4,041
Mills	935	5,950	5,705	4,304	-4	-25		4,304
Mitchell	922	14,183	12,477	14,351	-12	15	6,774	7,583
Nolan	444	2,373	2,126	2,433	-11	14		2,433
Reagan	1,068	3,007	1,983	3,105	-34	56		3,105
Runnells	1,060	21,821	18,903	16,771	-13	-11	7,978	8,793
San Saba	1,122	10,273	11,012	8,666	7	-21	3,400	5,266
Schleicher	1,050	2,887	2,812	2,601	-3	-8		2,601
Scurry	484	9,832	9,313	18,376	-5	97	12,010	6,366
Sterling	914	1,431	1,409	1,282	-2	-9		1,282
Sutton	651	364	516	486	42	-6		486
Taylor	286	1,559	1,678	2,409	8	44		2,409
Terry	873	8,765	8,648	12,933	-13	50	6,161	6,772
Tom Green	1,543	36,033	39,302	58,929	9	50	52,093	6,836
Travis	1,015	77,777	111,053	160,980	43	45	132,459	28,521
Upton	416	374	269	332	-39	23		332

APPENDIX III (continued)

County	Area in Basin (sq. mi.)	Population in Basin			Percentage Increase		1950 Population	
		1930	1940	1950	1940 over 1930	1950 over 1940	Urban	Rural
Wharton	287	8,884	10,822	10,798	22	0	4,450	6,348
Winkler	159	197	179	293	-9	64		293
Yoakum	830	1,263	5,354	4,339	324	-19		4,339
Basin Totals								
New Mexico	1,851	5,697	16,629	23,288	192	40	16,918	6,370
Texas	40,712	469,205	516,175	634,238	10	19	374,102	260,136
GRAND TOTALS	42,563	474,902	532,804	657,526	12	23	391,020	266,506

APPENDIX III (continued)
POPULATION OF CITIES IN COLORADO RIVER BASIN
(over 2,500 persons in 1950)

Community	County	Census 1930	1940	1950
New Mexico				
Hobbs	Lea	598	10,619	13,801
Lovington	Lea	961	1,916	3,117
Texas				
Andrews	Andrews	---	611	3,294
Austin	Travis	53,120	87,930	132,459
Ballinger	Runnells	4,187	4,472	5,302
Bastrop	Bastrop	1,895	1,976	3,176
Big Spring	Howard	13,735	12,604	17,288
Brady	McCulloch	3,983	5,002	5,944
Brownfield	Terry	1,907	4,009	6,161
Brownwood	Brown	12,789	13,398	20,181
Coleman	Coleman	6,078	6,054	6,530
Colorado City	Mitchell	4,671	5,213	6,774
Columbus	Colorado	2,054	2,422	2,878
Eagle Lake	Colorado	2,343	2,124	2,787
Elgin	Bastrop	1,823	2,008	3,168
Fredericksburg	Gillespie	2,416	3,544	3,854
Giddings	Lee	1,835	2,166	2,532
La Grange	Fayette	2,354	2,531	2,739
Lamesa	Dawson	3,528	6,038	10,704
Llano	Llano	2,124	2,658	2,954
Menard	Menard	1,969	2,375	2,685
Midland	Midland	5,484	9,352	21,710
Odessa	Ector	2,407	9,573	29,495
San Angelo	Tom Green	25,308	25,802	52,093
San Saba	San Saba	2,240	2,927	3,400
Seminole	Gaines	---	1,761	3,479
Smithville	Bastrop	2,296	3,100	3,379
Snyder	Scurry	3,008	3,815	12,010
Wharton	Wharton	2,691	4,386	4,450
Winters	Runnells	2,423	2,335	2,676
	TOTAL	170,227	245,721	391,020

APPENDIX IV

COLORADO (OF TEXAS) RIVER BASIN

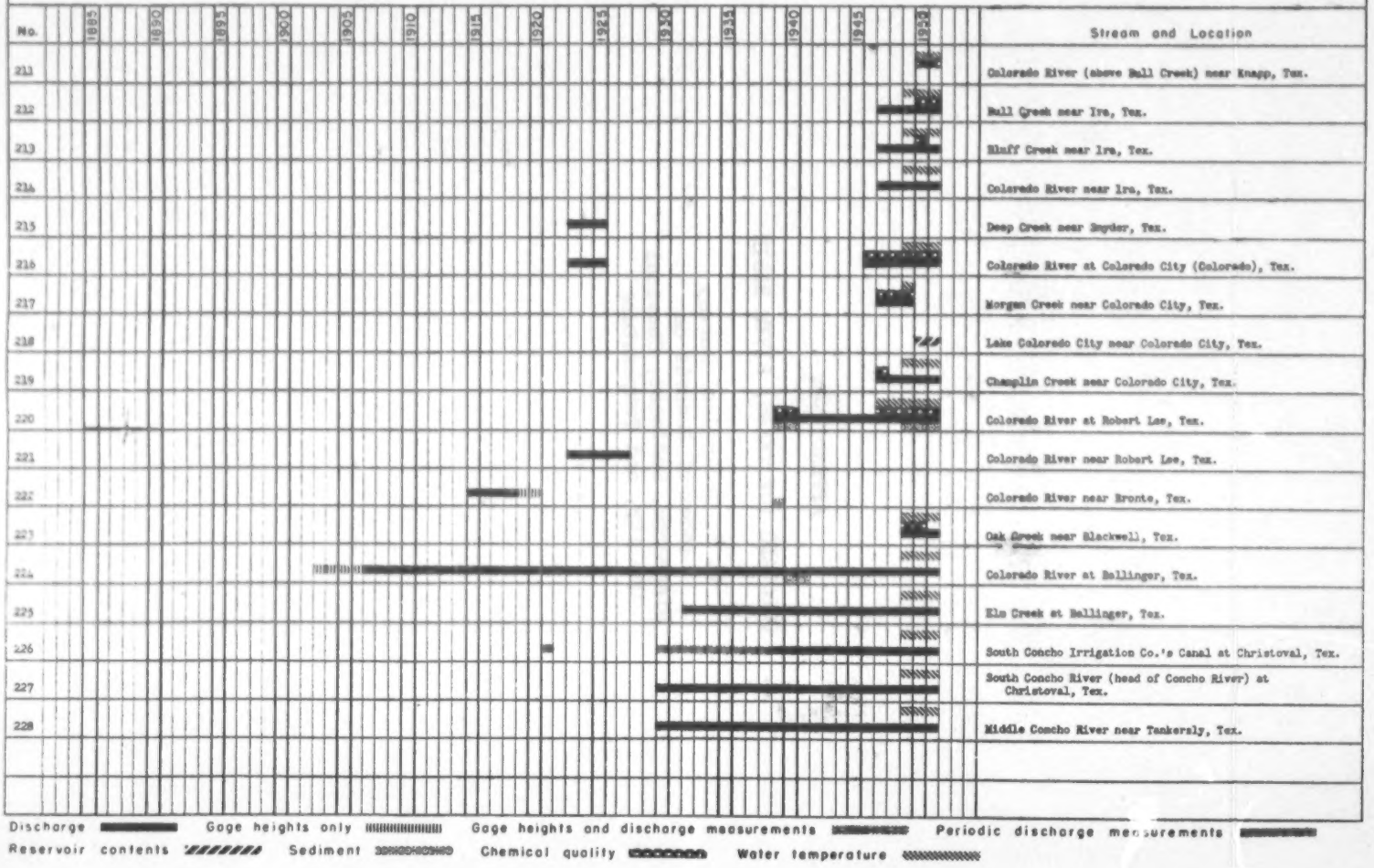
U. S. Geological Survey
Index of Records on
Discharge, Sediment, Chemical
Quality, and Temperature

COLORADO RIVER BASIN

Index of records collected by the U. S. Geological Survey and other agencies at the same location

Discharge, Sediment, Chemical Quality, and Temperature — Calendar Years

(Index does not identify partial year records)

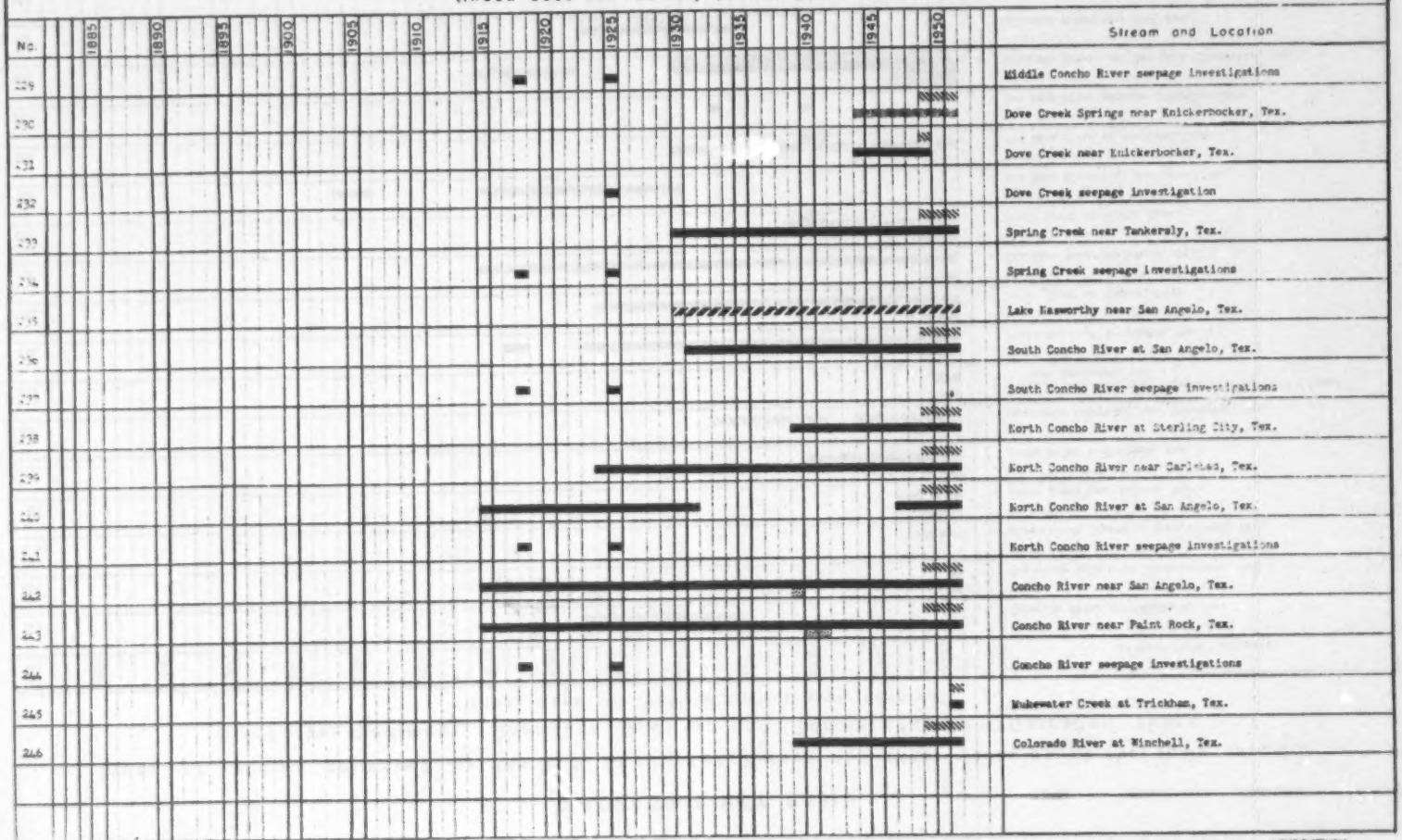


COLORADO RIVER BASIN

Index of records collected by the U. S. Geological Survey and other agencies at the same location

Discharge, Sediment, Chemical Quality, and Temperature — Calendar Years

(Index does not identify partial year records)

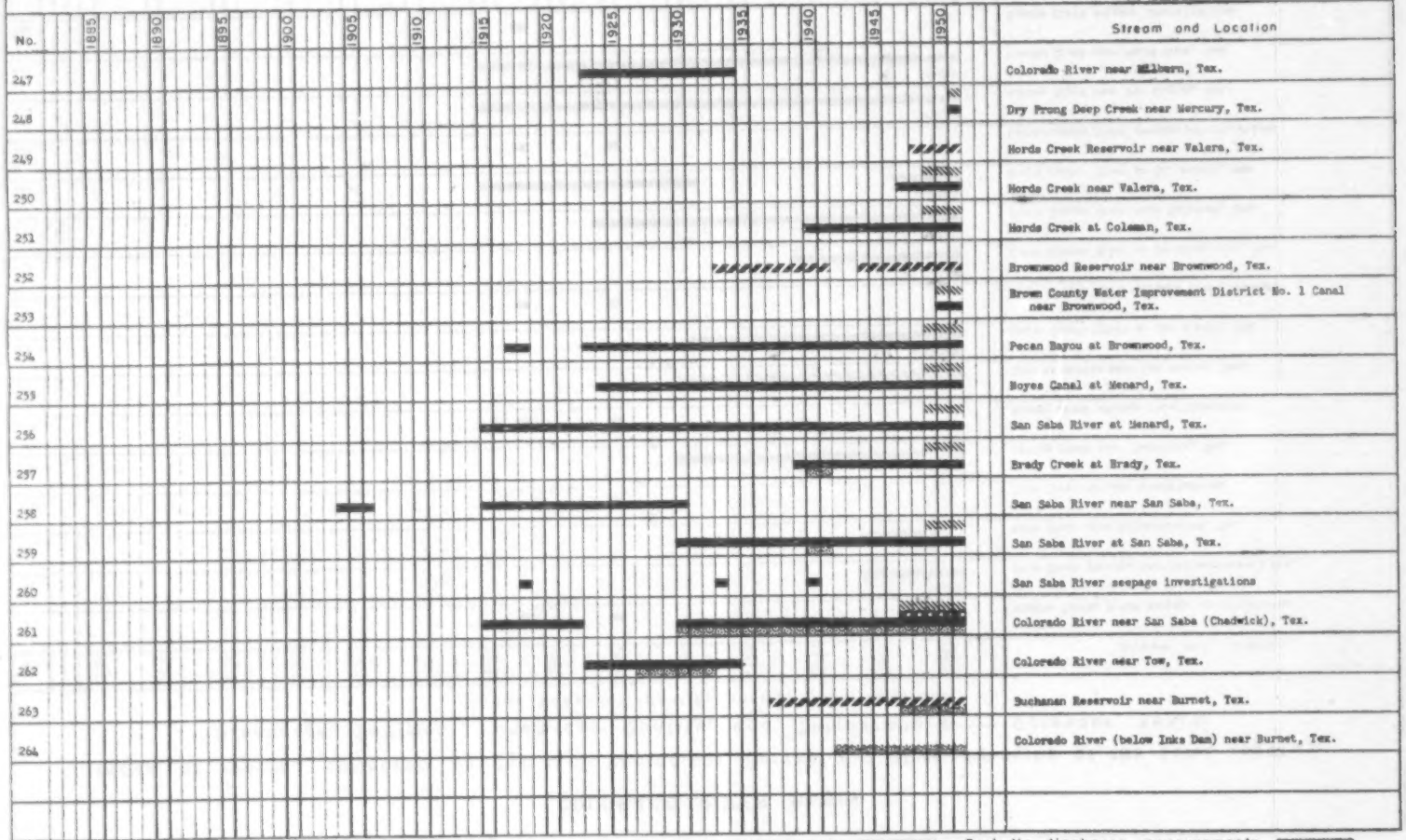


COLORADO RIVER BASIN

Index of records collected by the U. S. Geological Survey and other agencies at the same location

Discharge, Sediment, Chemical Quality, and Temperature — Calendar Years

(Index does not identify partial year records)



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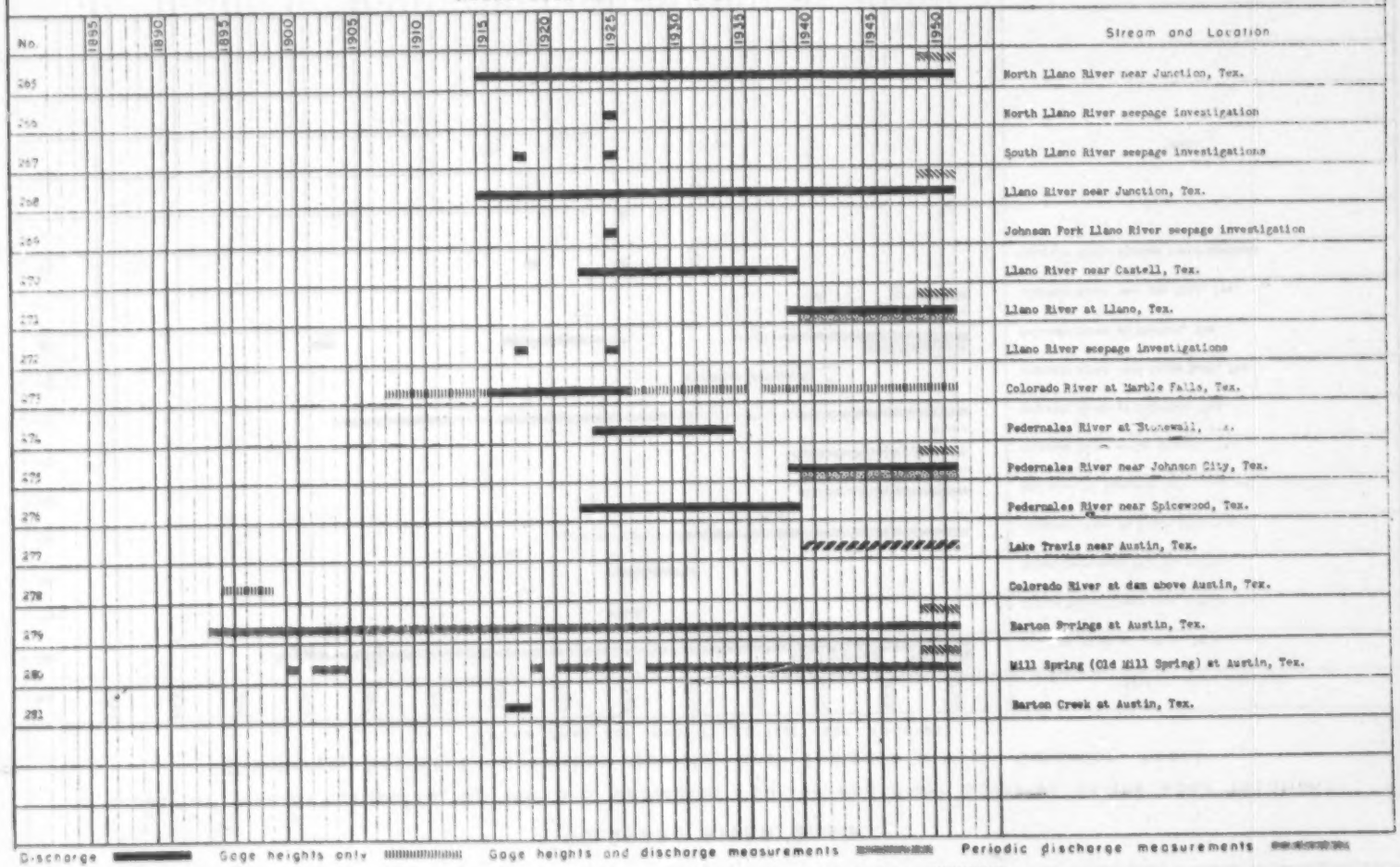
Index of records collected by the U. S. Geological Survey and other agencies at the same location

Discharge, Sediment, Chemical Quality, and Temperature — Calendar Years

(index does not identify partial year records)



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COLORADO RIVER BASIN

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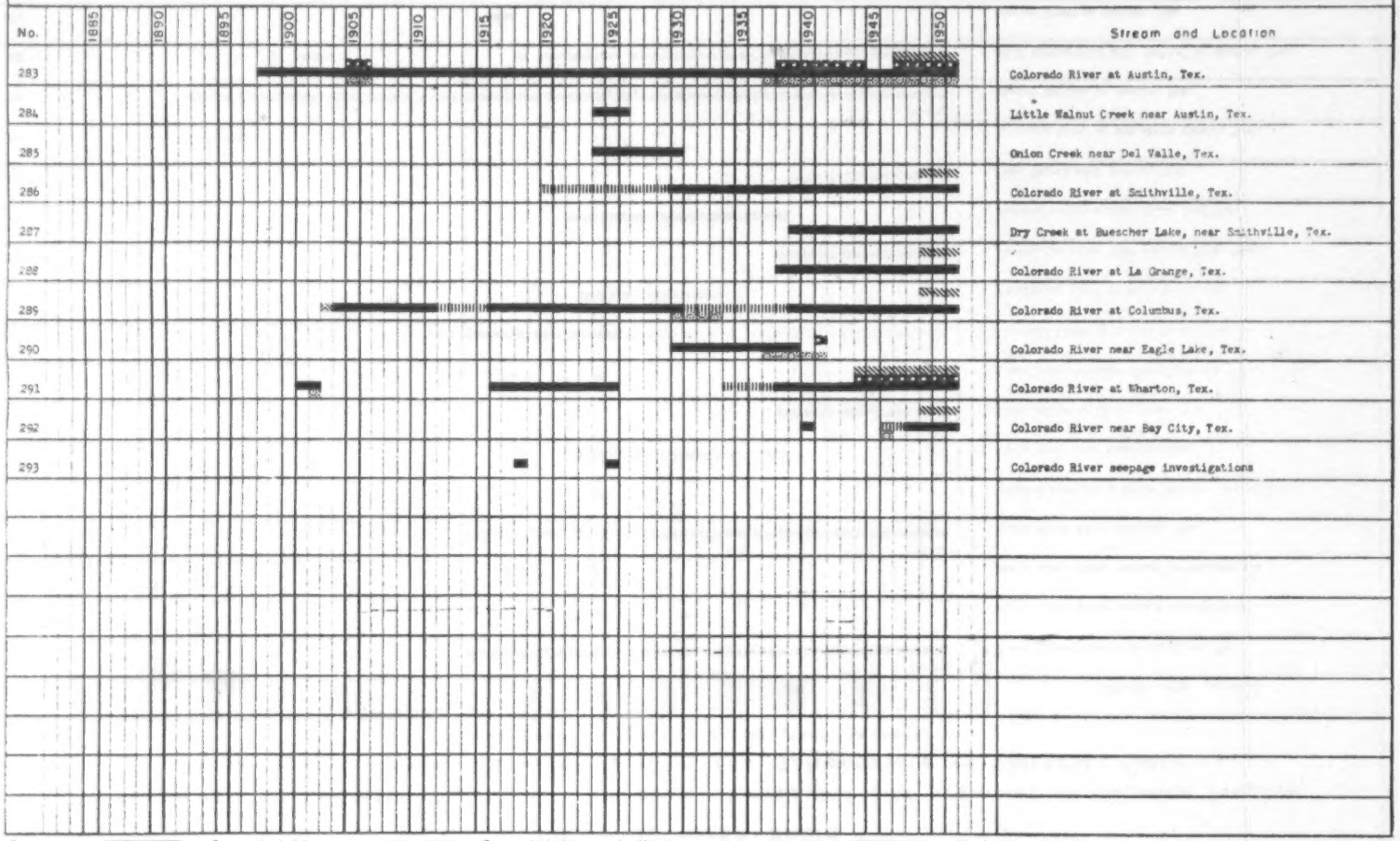
Discharge, Sediment, Chemical Quality, and Temperature — Calendar Years

(Index does not identify partial year records)



Discharge — Gage heights only — Gage heights and discharge measurements — Periodic discharge measurements

Reservoir contents — Sediment — Chemical quality — Water temperature